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CLEANUP:

GROUNDWATER REMEDIATION

PROJECT SUMMARY

TITLE: Air Sparging: Technology Transfer and Multi-Site Evaluation

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Department of Defense (DoD) is faced with the task of remediating many sites where groundwater is contaminated with a variety of compounds including petroleum and chlorinated compounds. Conventional groundwater treatment technologies are expensive and of limited effectiveness. Both the U.S. Air Force and the U.S. Navy have been developing in situ remediation technologies that have the potential to remediate sites much less expensively and more effectively than conventional technologies. Air sparging has been studied intensively at Port Hueneme, California to establish proper monitoring techniques for evaluating system performance and to determine critical operating parameters. Further demonstration of these air sparging monitoring techniques at different sites is needed to validate their application and enhance the acceptance of air sparging by regulatory agencies. Air sparging is the process of injecting clean air directly into an aquifer for remediation of contaminated groundwater. In situ air sparging remediates groundwater through a combination of volatilization and enhanced biodegradation. The induced air transport through the groundwater removes the more volatile and less soluble contaminants by physical stripping. Biological activity is also stimulated through increased oxygen availability.

Workshops for DoD personnel are being held to present recent findings from current air sparging studies. In addition, the air sparging design paradigm developed from the Port Hueneme study is being implemented at five different sites in order to test its validity across varying geologic conditions. Finally, pilot test data from previously installed DoD air sparging systems are being evaluated to extract information useful in finalizing the existing design paradigm.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Site specific test plan #4 for Ft Lewis, WA
- Site #3 installation at Cape Canaveral AFS, FL
- Site specific test plan #5 for Fairchild AIB, WA
- Site #4 installation
- Site #5 installation

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: An Innovative Passive Barrier System Using Membrane-Delivered Hydrogen Gas for the Bioremediation of Chlorinated Aliphatic Compounds

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to examine the gas transfer behavior and performance of hollow fiber membrane curtains that are installed as passive barriers. The proposed research will assess the suitability and effectiveness of the membrane for delivering hydrogen (H_2) to accelerate the in situ remediation of chlorinated organic compounds like trichloroethene (C_2HCl_3) and perchloroethene (C_2Cl_4). The proposed research will investigate the behavior of the membranes in a systematic way to determine what factors control the overall remediation process. These tasks include: (1) Gas Dissolution Behavior of Membranes, (2) Impact of Gas Composition Changes and Condensation, (3) Impact of Biofilm Growth during Gas Transfer, (4) Evaluation of Solvent Transformation, (5) Mathematical Model Development, and (6) Pilot Reactor Studies. The risks involved in this process include the following. (1) The membranes may not transfer H_2 fast enough when the groundwater is moving slowly. (2) The membranes may foul and their gas transfer performance may be lost. (3) Methanogens may exploit the high local H_2 pressure and grow preferentially. If this happens, most of the H_2 will be used to form methane gas which could accumulate locally and impede effective bioremediation by halorespirers. (4) The use of H_2 raises safety issues. In addition, the accumulation of locally high concentrations of methane are also of concern, since both H_2 and methane are flammable gases. (5) The accumulation of excessive biomass locally could cause a loss of permeability and a poor flow distribution through the affected site. (6) The installation process may damage the membranes and render them ineffective.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Construction of Test Reactors to determine Behavior of Membranes
- Impact of Gas Composition Changes/Condensation on recirculating gas flow
- Impact of Fouling by inorganic chemicals on Gas Transfer
- Characterization of biofilm impact on Gas Transfer
- Feasibility of using membrane for halorespirer selection for Gas Transfer
- Ability to control H_2 pressure during the Evaluation of Solvent Transformation
- Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Project initiated late in fiscal year due to delays in contracting. Therefore, contractor partially met the original objectives for FY99 as stated above.

PROJECT SUMMARY

TITLE: Aquifer Restoration by Enhanced Source Removal

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Low-solubility organic compounds such as chlorinated solvents were used and released to the environment in massive quantities during the 1950s, '60s, and '70s. These contaminants have migrated through the subsurface and entered groundwater at more than 1,000 Department of Defense (DoD) sites. At these sites, the organic contaminants are found in one of four phases: (1) volatilized within the soil's vadose zone (vapor phase), (2) dissolved in the groundwater (dissolved phase), (3) sorbed to the aquifer solids (sorbed phase), or (4) as a separate non-aqueous phase liquid (NAPL) phase. All of these phases contribute to groundwater contamination and need to be removed. The limiting factor to satisfactory remediation at over 75 percent of the hazardous waste sites in the United States is the restoration of groundwater quality. The major limitations of the successful use of pump-and-treat technology are related to difficulties in extracting contaminants from source areas where NAPLs exist. The objective of this research is to evaluate extraction processes (solubilization and mobilization), that have been developed at the bench scale, for their potential to enhance extraction in the source area. Design manuals are to be developed and evaluated using field pilot-scale cells for side-by-side comparison of technologies. The proposed work will be a series of field demonstrations of enhanced pump-and-treat technologies supported by site characterization and laboratory research required to produce credible field demonstrations and evaluations. The work will focus on remediation of source areas of sites believed to be contaminated by NAPLs at residual concentration (no longer mobile and, therefore, not available for extraction by pumping). The processes will be demonstrated at different sites with a variety of hydrogeologic characteristics and chemical mixtures (both NAPLs and sorbed contaminants will be considered) to determine their performance under a variety of conditions. The tests will be conducted as controlled small-scale field projects. Each technology will be compared to one or more alternative remediation technologies including conventional pump-and-treat as a reference treatment system. The results of these comparisons will show the differential improvement achieved by one process relative to another. Success of the project will be dependent on: the ability to obtain access to actual sites and obtaining regulatory permission to perform non - standard, pilot-scale evaluations without significant delay.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Published an Interim DNAPL Report on cosolvent solubilization
- Initiate air sparging demonstration for DNAPL removal
- Completed DNAPL cosolvent solubilization demonstration
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Bioenhanced In-Well Vapor Stripping to Treat Trichloroethylene

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to demonstrate the potential of combining two innovative, recently demonstrated, remediation technologies, in-well vapor stripping and in-situ aerobic cometabolic bioremediation, to cleanup an area contaminated with separate phase Dense Non-Aqueous Phase Liquid (DNAPL) and dissolved phase Trichloroethylene (TCE). Under this project, an in-well vapor stripper will be installed in a TCE contaminated "hot spot zone", upgradient from a downflow biotreatment well located at Edwards AFB, CA. In operation, the in-well vapor stripper will use air-lift pumping to pump contaminated water from the lower portion of the aquifer to a screened interval above and below the water table. Approximately 90-99 percent of the volatile organic compound (VOC) will be stripped out of the water into the gas phase, which will subsequently be treated using granular activated carbon. The treated water leaving the upper screen of the in-well vapor stripper will flow to the upper screen of the biotreatment well. Water entering the biotreatment well will be pumped down through the well, where a primary substrate such as toluene will be added. Oxygen may also need to be added in the biotreatment well, though it is possible that the oxygen dissolved during the in-well vapor stripping will be sufficient to support the aerobic bioremediation process. After addition of the primary substrate (and possibly, oxygen), the water will be injected into the aquifer through the lower screened interval, where indigenous microorganisms can aerobically metabolize the primary substrate and cometabolize the contaminant. A portion of the water leaving the bioactive zone will recirculate back to the lower screen of the in-well vapor stripper for further treatment. The combined technology of bioenhanced in-well vapor stripping should remove as much or more TCE from the groundwater than would be removed compared to conventional technologies (e.g., pump-and-treat). Because each technology is currently being demonstrated independently, the main technical challenge and risk comes from the integration of the two, which can be dealt with by adjusting various operating parameters (e.g., gas flow in the stripping well, primary substrate feed in the biotreatment well, water flow rates) to optimize performance.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete system testing
- Submit work plan for regulator approval
- Regulator approval of work plan
- EPA forward funds to WRHSRC
- Commence site construction
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Characterization and Optimization of Dual Anaerobic/Aerobic Biofilm Process

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0605502F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This effort was to develop and characterize a process that promotes simultaneous anaerobic degradation of perchlorethylene (PCE) and aerobic degradation of trichloroethylene (TCE), 1,1,1-trichloroethane, and cis-dichloroethene (cis-DCE), in a single bioreactor.

A field demonstration was conducted at McClellan AFB CA using a dual aerobic/anaerobic fluid bed reactor system. During the field demonstration, TCE, PCE, and cis-DCE were removed with 99%, 99%, and 84% efficiency, respectively, and the effluent met California Maximum Concentration Levels (MCLs) for all target contaminants. The technology proved to be more cost-effective when compared to other developing technologies, including: ultraviolet oxidation with liquid-phase granular activated carbon (LGAC), and air stripping with thermal combustion and LGAC post-treatment. LGAC post-treatment is often necessary to meet limits for some of the chlorinated compounds.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Determine treatment effectiveness for 1,1,1-TCA, cis-DCE, TCE, chloroform and PCE
- Evaluate complex electron donors for PCE reduction
- Assess temperature and shock loading effects
- Field test the pilot demonstration
- Complete draft final report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Dem/Val of Fuel-Specific Bioslurper System Modifications for Enhanced Cost-Effectiveness

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Approximately 1,000 Department of Defense (DoD) cleanup sites contain phase-separated hydrocarbons on the water table. Removal of floating fuel at these sites is often accomplished using bioslurping systems. The mixing of soil gas with fuel and ground water within the extraction well, vacuum manifold, and vacuum pump during bioslurping has contributed to excessive production of contaminant streams, which often require separate treatment. Conventional post-pump treatment systems require high capital and operation and maintenance costs. Excessive emulsions and suspended solids levels in the extracted liquids can also damage the pump and oil-water separator, thus incurring additional costs and operational delays. This project will demonstrate newly developed vacuum drop tube designs and pre-pump separators for bioslurper systems, which in preliminary evaluations have been effective in greatly decreasing stable emulsion formation, and system off-gas and effluent water contamination.

This project involves field demonstrations of effective bioslurper system modifications: in-well dual vacuum drop tube designs and aboveground pre-pump dropout tank modifications. The dual drop tube incorporates a baffle around the base of a conventional vacuum drop tube, which prevents the extraction of fuel while allowing groundwater to enter the drop tube from beneath the baffle and soil gas to enter from the top of the baffle. A separate smaller drop tube, located outside of the baffle, is used to remove any accumulating fuel. The aboveground pre-pump dropout tank operates in a similar manner, except that it separates oil and water coming from all wells. The aboveground scheme has been shown to be less efficient than in-well separation but could be cost-effective at sites with less severe effluent discharge limitations. However, in-well separation costs would decrease if the effective baffle size could be decreased to accommodate smaller diameter wells. The best approach may be to design a bioslurper system with both in-well and pre-pump dropout tank separation, whereby fuel pumped separately from the wells would enter the pre-pump vacuum dropout tank, and each would provide for a fail-safe system. To develop good cost and performance data, these two fuel-water separation schemes will be demonstrated through short-term testing at six field sites and long-term testing at one site.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Demonstration start date
- Award Contract - year #1
- Complete draft short-term demonstration plan - to ESTCP
- Complete field demonstration site assessments and selections - six sites for short-term demos
- Complete Letter Report to ESTCP- Site selections
- Complete portable bioslurper system fabrication - including system modifications
- Start short-term field demonstrations - two to five weeks at each of five field sites

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Demonstration of Bioaugmentation at Naval Air Station Fallon (NASF), NV

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Department of Defense (DoD) has chlorinated solvent-contaminated groundwater at many of its sites. Current methods of remediation have proved costly and not wholly effective. DoD would benefit from alternative methods of remediation. The purpose of this project is to demonstrate the general applicability of bioaugmentation as an enhancement to biostimulation methodologies for the remediation of chlorinated solvents in groundwater.

Accelerated anaerobic biodegradation consists of adding non-toxic electron donors (carbon sources) and nutrients into the subsurface to promote the complete in situ reductive dehalogenation of chlorinated solvents. It is a reasonable remedial option when natural attenuation is either not fast or complete enough to eliminate risk to human health and the environment. A recently completed field study at Dover Air Force Base (AFB), DE indicated that accelerated biodegradation can be limited by the lack of the appropriate microorganisms capable of the complete dehalogenation of the chlorinated aliphatic compounds. In this test, addition of a non-native dehalogenating culture resulted in complete dehalogenation of trichloroethylene to ethene throughout the test cell, representing the first successful field application of bioaugmentation to stimulate complete anaerobic dehalogenation of chlorinated aliphatic compounds. The project studied at Dover AFB will be duplicated at NASF to determine if it can be equally successful in more challenging soil and groundwater conditions.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Contract Award to Battelle, GE, SCG, Geosyntec
- Site Visit to Fallon NAS
- Microcosm Study Lab analysis procedures letter to ESTCP
- Draft Demo Plan Prepared
- Start Lab Biotreatability Study
- Start lab analysis of site soils
- Initiate permitting and regulatory process
- Microcosm results and Final site determination

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Development of Effective Aerobic Cometabolic Systems for the In-Situ Transformation of Problematic Chlorinated Solvent Mixtures

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The project objective is to remediate Trichloroethylene (TCE) and other chlorinated organic compounds in soil and groundwater. The goal of the proposed research is to demonstrate the potential of using propane and butane-utilizing microorganisms to transform problematic Chlorinated Aliphatic Hydrocarbons (CAH) mixtures. The demonstration will be aimed towards creating in situ bioreactive passive barriers in contaminated aquifers. Oregon State University research with microorganisms stimulated on propane or butane has demonstrated the potential for transforming a broad range of CAH mixtures that have been problematic with other cometabolic substrates. Microcosm studies conducted with subsurface solids and groundwater from contaminated Department of Defense (DoD) sites, however, have shown that propane and butane-utilizers are often absent in the subsurface, or have long lag periods before effective stimulation is achieved. Thus the implementation of effective in situ treatment systems at many sites will likely require the bioaugmentation of enrichments. The proposed work will demonstrate effective methods to create passive treatment barriers through both bioaugmentation and the use of a subsurface delivery system. The bioaugmentation will serve only to add effective propane or butane-utilizers to the treatment zone. Microbial growth and maintenance for effective cometabolic treatment will be achieved through propane or butane addition to the subsurface. In addition, the project will explore the use of mixed cometabolic substrates for the treatment of problematic CAH mixtures.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- CAH mixture studies
- Microcosm bioaug. does tests
- Growth reactor studies
- Selection of bioaug. enrichment
- Derivation of Kinetic Parameters
- Development of Molecular Probes
- Modeling of lab results
- Modeling design field bioaug study
- Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Enhanced Alternative and In-Situ Treatment Technologies for Explosives, Organics, and Solvents in Groundwater

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will demonstrate improved, cost-effective, alternative forms of groundwater remediation for explosives and other organics contaminants. The overall technical approach will:

- Develop technologies and engineering approaches to enhance biological degradation of contaminants in groundwater.
- Develop new in-situ chemical treatment technologies focusing on metal enhanced reactive transformation for explosives.
- Combine chemical/biological techniques to accelerate and improve treatment effectiveness for explosives and other organics in groundwater.

In-situ biotreatment approach degrades explosives and organics without the need for pump and treat systems currently used for groundwater treatment as identified in Army requirements. In-situ technologies eliminate the use of pump and treat systems, which are often expensive, only marginally effective, and require O&M for 15-20 years.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Continue development of design guidance for enhanced biodegradation
- Initiate setup and parameterization for pilot-scale testing using the Experimental Controlled Release System (ECRS)
- Conduct bench-top analysis to identify optimum parameters for reactive barrier treatment design

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Enhanced Natural Attenuation in Comingled Plumes

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective is to enhance natural attenuation rates in a comingled plume (combined presence of fuel and chlorinated hydrocarbons) through increased mixing, amendment, and removal of toxic by-products. The Navy has over 1000 sites that have groundwater contaminated with chlorinated hydrocarbons with an estimated cost for cleanup of over \$3B. Natural attenuation is the preferred remediation approach for comingled plumes both in terms of cost and contaminant destruction. Nonetheless, natural attenuation has limitations. Electron acceptors and electron donors are often depleted resulting in the cessation of natural attenuation. Even in cases where electron acceptors and donor concentrations are adequate, natural attenuation will not be protective of human health and the environment if there is incomplete mixing resulting in mass transfer limitations and inadequate bioavailability. A field demonstration of enhanced natural attenuation will be conducted at a chlorinated solvent plume at Moffett Federal Airfield.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Select demonstration site
- Establish contracts
- Complete system design and site modeling
- Complete development and approval of Work Plan
- Install and develop treatment wells

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Evaluation of Performance and Longevity at Permeable Reactive Barrier Sites

BUDGET ACTIVITY: 3 and 4

PROGRAM ELEMENT: 0603851D and 060716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Chlorinated hydrocarbon contamination of groundwater is a growing problem at many Department of Defense (DoD) sites. Traditional methods of remediation (e.g., groundwater pump and treat technologies) for these sites have proven both ineffective and very expensive. DoD would benefit enormously from the use of an alternate method. The permeable reactive barrier (PRB), or treatment wall, is an innovative technology that has the potential to become one of the more promising alternatives for remediation of groundwater contaminated with chlorinated hydrocarbons. The technology is based upon an abiotic chemical (oxidation-reduction) reaction, in which zero-valent iron particles react with the chlorinated hydrocarbons to produce non-toxic and easily biodegradable by-products. At present, there are about 15-20 PRB sites being demonstrated nationwide, some of which have been operating for a period of up to 5 years. However, the widespread use and acceptance of this technology is rather limited, because remedial project managers and regulators do not have a good understanding of the overall long-term performance issues. In the absence of such information, site owners and managers are likely to be required to implement the traditional expensive remedial systems and/or costly monitoring systems for regulatory compliance. This lack of knowledge defeats the objective of prescribing a cost-effective and environmentally sound remedial solution. This project, in coordination with similar Environmental Protection Agency and Department of Energy efforts, will demonstrate the use of PRB technology to remediate groundwater contaminated with chlorinated hydrocarbons. This project will evaluate short and long term performance issues at selected PRB sites. The evaluations will include identifying methods to predict PRB longevity and establishing standardized sampling and analytical procedures for PRBs. A monitoring protocol will be developed and applied to five DoD PRB sites. The ultimate project goal is to gain regulatory acceptance and encourage remedial project manager confidence in using the PRB technology.

This project was jointly funded by SERDP and ESTCP in FY99.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Establish regular conference calls with other DoD tri-service partners and RTDF collaborators
- Considering bi-weekly or monthly conference calls and quarterly or semi-annual meetings
- Obligate funds to RAC-IT contractor (Battelle)
- Field Monitoring Survey & DoD Demo Site Selection and coordination with DOE & EPA selected sites
- Demo Site Selection Report will include results from surveys from DoD, DOE & EPA sites
- Draft Sampling Procedure Workplan for intended use at DoD, DOE, & EPA PRB sites
- Annual field performance monitoring and collection of coring samples from DoD PRB demo sites
- Final Field Monitoring Workplan for use at all DoD, EPA, and DOE selected sites
- Annual Report of findings from performance monitoring and coring at various PRB sites

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Influence of Groundwater Constituents on Longevity of Iron-Based Permeable Barriers

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project investigates factors which may limit the longevity of iron-based permeable barriers used for in situ treatment of organic - or metal-contaminated groundwater by examining the long-term performance of laboratory columns packed with a porous medium containing zero-valent metal solids and through which simulated groundwater of differing compositions is passed, by examining the influence of eluent composition and time on the evolving composition of the solid surfaces, and by monitoring the electrochemical characterization of the surfaces after varying times of exposure. Particular emphasis is placed on developing new approaches for "real-time" monitoring of changes in system performance through a novel electrochemical probe that can be installed in situ in pilot - or full-scale applications. The principal technical objectives are to evaluate the impact of groundwater composition on the long-term performance of zero-valent iron (Fe) barriers and to develop a prototypic electrochemical probe for monitoring reactivity changes at either the field or laboratory scale.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Uncoupling transport and reactivity effects
- Assessment of RTD and reactivity changes
- Monitoring of "follow-up" columns
- Construction of "follow-up" columns
- Operation of "initial" long-term columns (on-going)
- Comparison of reactivity to probe response
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: In-Situ Chemical Oxidation Process Using Fenton's Reagent

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective is to demonstrate an in-situ Fenton's reagent oxidation of toxic contaminants in soil and groundwater. The Users Data Package (UDP) including cost-effectiveness analysis will be prepared for other Navy IR sites' application. The Navy has identified many sites where the soil and groundwater have been contaminated with VOCs, SVOCs, TCE, PCE, DNAPLs, PCBs, and heavy metals. These contaminants are toxic to the environment and natural resources that they must be removed to meet regulatory requirements as well as to protect the environment from further encroachment. Removal of these contaminants by excavation of soil with offsite treatment and disposal and to pump-and- treat the contaminated groundwater is generally time consuming and very costly. Furthermore, there are many instances when this type of approach becomes prohibitive, such as the case where an underground utility corridor needs be protected and or the soil lithology disallows its application. A cost-effective remediation technology therefore, must be developed and field demonstrated to meet the Navy's installation restoration/site cleanup needs.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Conduct Phase II chemical injection
- Collect and analyze demonstration samples (Phase II)
- Prepare a cost and performance report
- TCE removal down to <100 ppb

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** In-Situ Redox Manipulation**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The objective is to evaluate the effectiveness of in situ redox manipulation (ISRM) to destroy volatile organic compounds (VOCs) in groundwater. This innovative technology involves injection of sodium dithionite to create an in situ reducing zone in normally oxidized aquifer sediments. The reducing zone acts to destroy VOCs by reductive dechlorination by a process similar to that, which occurs in a zero-valent iron reactive wall. Installation costs for ISRM are comparable to groundwater extraction and treatment systems; however, long-term maintenance and operation costs are expected to be significantly less. Reduced operating costs provide significant advantages for cleanup operations that are expected to require many years to complete. Most remediation projects attempting to remove VOCs from groundwater fall into this classification.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Prepare draft field implementation work plan
- Obtain regulator approval of final field implementation work plan
- Install and evaluate injection system
- Conduct tracer test
- Conduct field injection

ANNUAL PERFORMANCE REVIEW: The milestone for the tracer test has been rescheduled for 2/14/00.

PROJECT SUMMARY

TITLE: Molasses Induced Reactive Zones to Treat Metals and Chlorinated Hydrocarbons

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Chlorinated solvent contamination of groundwater is a widespread problem at many military and civilian facilities. Historically, Chlorinated Aliphatic Hydrocarbons (CAH) have been used for cleaning such diverse products as aircraft engines, automobile parts, electronic components, and clothing. Current technologies such as air sparging, pump-and-treat methods, and natural attenuation have limitations for the remediation of CAHs. The technology that will be demonstrated in this project is designed to modify aquifer conditions in-situ, thereby promoting faster biological degradation of the chlorinated aliphatic hydrocarbons, and to precipitate metals as insoluble sulfides.

Through subsurface reagent injection, existing aerobic or mildly anoxic aquifers will be altered to form highly anaerobic reactive zones while also providing a source of sulfide. Molasses is generally utilized as the primary form of organic carbon. Molasses is a commonplace, innocuous reagent and, from an engineering perspective, the injection equipment is simple and economical. Prior to the initiation of this remedy, the hydrogeology of each candidate aquifer is evaluated in order to properly disburse the reagent and to establish appropriate redox conditions in the In-Situ Reactive Zone (IRZ). Accurate hydrogeological information is essential to the placement of monitoring wells that will produce samples accurately reflecting the progress of the in-situ remediation. The timing and concentration of reagent introduction is important to the proper implementation of this technology. During this demonstration, initial bio-geochemical assessment and feasibility evaluation will be conducted at the following four demonstration sites: (1) Hanscom AFB, MA, (2) Vandenburg AFB, CA, (3) Former Naval Station Treasure Island, CA, and (4) Badger Army Ammunition Plant, WI. Implementation of the IRZ technology will be conducted at two sites initially, followed by the writing of a protocol and beta testing of this protocol at a third site. Once demonstrated and validated, an Environmental Security Technology Certification Program/Air Force Center for Environmental Excellence technical protocol will be issued.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Contract Award to ARCADIS Geraghty & Miller

ANNUAL PERFORMANCE REVIEW: Met all performance objectives. Project initiated late in fiscal year due to delays in contracting.

PROJECT SUMMARY

TITLE: Natural Attenuation of Chlorinated Solvent Groundwater Plumes Discharging Into Wetlands

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM: No.

DESCRIPTION: The Department of Defense (DoD) has many sites with chlorinated solvent groundwater contamination. There are concerns about groundwater plumes discharging into wetland environments at some of these sites. Traditional cleanup technologies are costly and may cause damage to sensitive wetland ecosystems. However, substantial beneficial transformation can occur within the highly reducing environment of wetland sediments - a development that suggests that natural attenuation may be a viable, cost-effective remediation option for discharges in wetlands. The purpose of this project is to demonstrate methodologies for the assessment of natural attenuation of chlorinated solvent-contaminated groundwater plumes discharging into wetland environments.

Natural attenuation comprises all processes that can reduce contaminant exposure concentrations. In most aquifers, trichloroethylene and other chlorinated solvents tend to be relatively resistant to degradation, leading to the development of long, chlorinated solvent plumes, which reach surface water discharge points, such as wetlands. Conditions conducive to transformation reactions (biotic and abiotic) tend to exist in the reduced organic-rich wetland sediment prior to discharge to the surface water; thus substantial natural attenuation can occur. The organic-rich sediment zones of wetlands are relatively thin compared to the thickness of most aquifers, requiring a high resolution groundwater sampling framework to assess natural attenuation. The key sampling strategy of this project is the use of multilevel piezometer transects. Sampling and analysis will focus on redox zonation and chlorinated solvent and degradation product concentrations. In this demonstration, natural attenuation will be evaluated at three DoD chlorinated solvent discharge wetland sites. Working with regulators and the Air Force Center for Environmental Excellence, a protocol for the assessment of natural attenuation as a remedial option at discharge wetlands will be developed.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Kick-Off Meeting
- Site Selection - Sites A & B (Aberdeen Proving Ground and Hill AFB)
- Reconnaissance - Site A
- Literature Review
- Draft Protocol Template
- Demo Plan - Site A
- Reconnaissance Site B
- Instrumentation of Site A
- Site Selection - Site C (Eglin AFB)

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Pilot Demonstration for Dense Solvent Remediation**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603723F**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The Cape Canaveral Air Station project was established to identify the best innovative and nearly mature technologies for cleanup of dense, nonaqueous phase liquid (DNAPL) source zones. DNAPLs are one of DoD's most refractory cleanup problems. The Cape Canaveral project team (Air Force, EPA, DOE, and NASA) designed a field demonstration for side-by-side testing of three promising technologies. Demonstrations were also designed to collect data that would lead to detailed cost and performance comparisons. All three technologies treat source zone contamination, meaning remediation time may be reduced from decades to months, as will costs for controls and long term monitoring.

ANNUAL PERFORMANCE OBJECTIVES FOR FY 99:

- Complete set up of three technologies for demonstration
- Begin side-by-side technology tests

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Push-Pull Tests for Evaluating the In Situ Aerobic Treatment of Chlorinated Solvent Mixtures in Groundwater

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Aerobic cometabolism is a promising technology for the in-situ remediation of chlorinated aliphatic hydrocarbons (CAH) at Department of Defense (DoD) sites. Low-cost methods are needed for generating the data required to design field-scale systems. This task is complicated by the complexity of the cometabolic process and the different cometabolic substrates from which to choose. The type and concentration of the contaminants are important considerations, along with the transformation abilities of the indigenous microorganisms that are stimulated on a specific substrate. In this project, a single-well, push-pull test method will be developed for determining parameters that are needed for full-scale remediation design. The method will be developed and tested in standard monitoring wells, providing a rapid, straightforward in-situ means of characterizing the cometabolic process of interest at a given site.

The single-well, push-pull method will be evaluated as a means of generating the data required for designing systems for the in-situ aerobic cometabolic treatment of CAH contamination in the saturated zone. The test consists of the controlled injection of a prepared test solution into an aquifer followed by the recovery of the test solution/groundwater mixture from the same location. Tests will be performed in existing monitoring wells using packers to isolate a portion of the aquifer. The test solution will consist of water-containing non-reactive tracers such as bromide, the cometabolic substrate of interest, dissolved oxygen, and reactive solutes that are designed to permit the estimation of the in-situ transformation rates of the CAHs of interest. At the project's conclusion a validated protocol for conducting push-pull tests will be issued.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Contract Award to Oregon State University

ANNUAL PERFORMANCE REVIEW: Met all performance objectives. Project initiated late in fiscal year due to delays in contracting.

PROJECT SUMMARY

TITLE: Surfactant Enhanced DNAPL Removal

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Dense nonaqueous phase liquid (DNAPL) contamination of groundwater is very difficult to remediate. Compounds, such as trichloroethylene (TCE), sink in aquifers due to gravitational pull and act as a continuous source for contaminant plumes that can stretch for miles within an aquifer. Deep, contaminated soils (more than 25 feet deep) are not amenable to soil excavation methods, and in situ biotransformation is slow and incomplete. This project will demonstrate an enhanced pump-and-treat system that uses chemical additives—surface-active agents (surfactants) - to remove DNAPL contamination from aquifers. When added to contaminated soils, surfactants greatly increase the solubility of DNAPLs, allowing the contaminants to be pumped out much more efficiently. This technology will also allow the surfactant compounds to be recycled and reused cost-effectively.

This technology uses a two-phased approach: removal of residual DNAPLs using surfactants, and aboveground treatment of the recovered surfactant-DNAPL wastes by pervaporation and micellar-enhanced ultrafiltration (MEUF). Surfactants are used to overcome the low aqueous solubilities of DNAPL by reducing the surface tension at the DNAPL-water interface. In the proposed typical remediation scheme, surfactants are used to remediate DNAPL source areas and to complement the use of conventional pump and treat systems for removing dissolved-phase DNAPL contamination. After a detailed site characterization is performed to locate and delineate the boundaries of the residual DNAPL, surfactants are selected depending on the soil type, DNAPL constituents, and hydraulic parameters of the contaminated subsurface, and on the requirements of the above-ground treatment system. Surfactant solution is applied at injection wells and wastes are recovered at extraction wells. The recovered surfactant-DNAPL wastes are first treated using pervaporation, a membrane process that removes volatile DNAPL components such as chlorinated solvents from the water and surfactants. The pervaporation-treated waste stream is then sent to a MEUF unit to concentrate the surfactants prior to reinjection.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Recharacterize test zone for DNAPL removal
- Start surfactant demonstration
- Complete Analysis of Samples from SEAR and post-SEAR PITT

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Treatability Test for In Situ Anaerobic Dechlorination

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The U.S. Air Force is responsible for remediating approximately 600 sites that are contaminated with chlorinated solvents such as tetrachloroethylene (PCE) and trichloroethylene (TCE). The U.S. Navy, U.S. Army, and private industry have similar problems. While pump-and-treat strategies have been applied for plume containment purposes, no accepted technologies currently exist that completely remove or destroy chlorinated solvents in groundwater. A treatability testing procedure for implementing in situ anaerobic dechlorination will be developed and then demonstrated at five U.S. Department of Defense (DoD) sites contaminated with chlorinated solvents.

In situ anaerobic dechlorination involves the addition of nontoxic electron donor substrates to enhance degradation of chlorinated contaminants by indigenous bacteria. In the initial phase of this project, a protocol was drafted to outline how treatability tests of enhanced anaerobic dechlorination should be conducted. The protocol covers such areas as hydrogeological and geochemical site characterization, microcosm studies, field treatability tests, test monitoring, data interpretation, and design guidance for a site-specific full-scale system. The protocol was written jointly by key professionals in the areas of microbiology, microbial ecology, biochemistry, hydrogeology, geochemistry, and field-scale engineering implementation and was peer-reviewed by a larger group of experts in those areas. The protocol is currently being implemented at five DoD sites contaminated with chlorinated solvents. When the field tests are complete, the expert panel will reconvene to review performance data and make recommendations for changes or additions to the protocol. The final document will contain detailed cost information on conducting the treatability tests, estimated cost information for full-scale design and implementation, and detailed technical information generated from the five demonstrations.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Initiation of field test #1 (Cape Canaveral Air Station, FL)
- Draft Technology Demonstration Plan #2 to ESTCP and to Site #2 (Alameda NAS, CA)
- Receipt of comments from ESTCP and Base #2 on Technology Demonstration Plan
- Technology Demonstration Plan #2 finalized
- Receipt of applicable permits and regulatory approval - Site #2
- Initiation of field test #2

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Treatment of Trichloroethylene using Alternatively Fed Dual Co-substrates

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0605502F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The AF has over 600 sites contaminated with chlorinated solvents (perchloroethylene and trichloroethylene) that require cleanup. Current baseline technology, "pump and treat" via air stripping or carbon sorption, is considered non-destructive, merely transferring contaminants from one media to another. A preferred approach would be a complete destructive technique such as bioremediation.

This effort was designed to evaluate the feasibility of using dual primary substrates for cometabolic trichloroethylene (TCE) destruction in a field-scale fluid bed reactor. Laboratory testing was conducted to obtain a better understanding of the process and determine the best operating regimes; field testing was done at an abandoned fire training area at the former Wurtsmith AFB MI for soil and groundwater remediation; and finally, system was field tested at a former manufactured gas plant (MGP) groundwater site containing a mixture of chlorinated ethanes and ethenes. The two field trials confirmed that TCE can be readily transformed, and high removal efficiency consistently achieved, in a fluid bed reactor. Infiltration of treated effluent to promote *in-situ* remediation and soil flushing at Wurtsmith AFB proved successful.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete field demonstration at former Wurtsmith AFB MI
- Complete field demonstration at former MGP
- Submit draft final technical report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Use of Cometabolic Air Sparging to Remediate Chloroethene-Contaminated Groundwater Aquifers

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Chlorinated aliphatic hydrocarbons (CAHs), used for years as industrial cleaners and degreasers, are common groundwater contaminants on federal sites. The Air Force alone has over 600 sites contaminated with chlorinated solvents that may require cleanup. There is an obvious need for remediation technologies with inexpensive installation costs and low operation and maintenance requirements. This project is intended to demonstrate that air sparging coupled with cometabolic biodegradation has the potential to satisfy these requirements for CAH contaminants.

Air sparging involves the injection of air into the saturated zone using conventional wells and blowers. This process employs two mechanisms to remove contaminants from the groundwater: contaminants are stripped via mass transfer to gas bubbles rising to the surface, and contaminants are biodegraded in situ via biological activity stimulated by the introduction of oxygen. This project will augment the techniques typically employed with air sparging by also injecting a gaseous co-substrate such as propane. Co-substrates promote degradation of CAH compounds during degradation of the co-substrate itself. Through cometabolism, CAHs are transformed to non-toxic by-products. Cometabolic air sparging is being demonstrated using two air injection wells, one with and one without a co-substrate. Data will be collected to determine the following: the air sparging radius of influence; subsurface air and propane distribution; co-substrate degradation; oxygen uptake; efficiency of co-substrate usage; relative contributions of contaminant stripping versus cometabolic biodegradation; the ability to degrade different CAH compounds; long-term stability of the cometabolic biological process; and the ability to maintain aerobic groundwater conditions.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Interim Technical Report for Site 1
- Aerobic Microcosm Protocol
- "In-Progress Review" Presentation to ESTCP Apr 1999
- Initiated field testing at McClellan AFB, CA

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Value Added Site Monitoring and Infrastructure Maintenance for In-Situ Bioremediation

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objectives of this project included: the continued serial monitoring of intrinsic bioremediation processes at three fuel and solvent contaminated sites at the former Wurtsmith Air Force Base; the support, maintenance, and supplementation of the data in a relational database management system (RDBMS); and the statistical analysis of the data for spatial and temporal variability, estimates of mass removal rates and indicators of bioremediation process change. The technical approach consists of a phased approach to the objectives outlined above. State of the art contaminant and geochemical ground water monitoring will be continued on a quarterly basis at three fuel and solvent contamination sites that have distinct oxidation-reduction zones. Indicators of corresponding bioremediation indicators and the mass of contaminants associated with aquifer solids will be determined as well. Additional, statistical analyses of the time-series and spatial distribution of contaminants and geochemical conditions will be evaluated for sources of error and variability. Bioremediation performance indicators will be developed in selected oxidation-reduction zones. Several years of data exist for the three study sites, which will provide a basis for the use of RDBMS and results of the statistical analyses by leading bioremediation modeling and remedial design groups.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Continue quarterly monitoring; enter these data and that of collaborators
- Maintain web-page access to internal and external collaborators and publish reports on data reliability, temporal trend analyses and error identification
- Test hypothesis 1 using data from the KC-135 crash site, the FT-2 site, and other sites where verified data are available
- Publish technical papers, reports, and give presentations to practitioners on the reliability of hydrocarbon rate constants in discrete redox zones

ANNUAL PERFORMANCE REVIEW: Project canceled due to lack of technical progress.

CLEANUP:

**HAZARD/RISK ASSESSMENT FOR
MILITARY COMPOUNDS**

PROJECT SUMMARY

TITLE: Biological Assessment for Characterizing Contaminant Risk at the Genetic-, Individual-and Population Level

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop a suite of technically defensible assays that can be effectively used in regulatory programs to quantify the ecological risk of contaminated sediments at the molecular-, individual-, and population-level. Researchers will quantify the biological/ecological meaning of genetic responses, collected using genosensors, by way of comparison to whole-organism assessments of toxicity and modeled population-level impacts. Dose-response information will be simultaneously generated using genosensors and whole-organism bioassays for such military-relevant compounds as explosives Trinitrotoluene (TNT), Cyclotrimethylenetrinitramine (RDX), Cyclotetramethylenetetranitramine (HMX), other organic compounds such as Poly Chlorinated Biphenyls (PCB), Polycyclic Aromatic Hydrocarbon (PAH), and metals such as Lead (Pb). During the first phase of this project, 1) sediments will be spiked with single military-relevant compounds (i.e., explosives and other organic compounds) and mixtures at a range of concentrations, 2) sediment-dwelling organisms will be exposed to these contaminated sediments, 3) the sediments and organisms will be screened for the presence of genetic markers using developed genosensors, and 4) whole-organism effects on survival, growth and reproductive endpoints will be measured. Four sediment-dwelling organisms will be used in this project that are currently being used by the Environmental Protection Agency (EPA) and the Corps to develop chronic, sublethal sediment bioassays for national regulatory programs. Two of the species occur in marine habitats (*Neanthes arenaceodentata* and *Leptocheirus plumulosus*) and two of the species are found in freshwater habitats (*Hyalella azteca* and *Chironomus tentans*). Impacts at the population-level will be projected using population models developed for bioassay organisms during the course of this study. By simultaneously measuring biological responses at three distinct levels of biological organization (i.e., genes, whole organisms, populations) the team of researchers will have the ability to effectively test the reliability of estimating potential risk at higher levels of organization (e.g., ecosystems) using information that can be quickly and inexpensively collected at lower levels of organization (i.e., the level of genes). During the second phase of study, the bioassay suite will be tested using naturally contaminated sediment containing even more complex mixtures of military-relevant and conventional contaminants. The comparisons made among the endpoints at each level of organization using field collected sediments ranging in degree of contamination will allow researchers to test how robust their predictions will be under a regulatory use scenario.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- TNT, RDX, HMX whole-organism exposure experiments
- Macrofauna nucleic acid methods development
- Genosensor array assays of exposed organisms
- *Hyalella azteca* population experiments conducted
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Genosensor Based Ecotoxicity Response Assessment

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop cost effective methods and instrumentation for directly monitoring genotoxic exposure in a variety of natural ecosystems. Direct measurements of the in-situ biological responses associated with genotoxic exposure of sentinel species in the environment circumvents the difficult problem of bioavailability, since measurable molecular endpoints in resident species are a direct reflection of ecologically relevant exposure. This project intends to implement emerging biochip technology for in-situ monitoring of molecular endpoints of genotoxic exposure, including Deoxyribonucleic Acid (DNA) damage-inducible gene expression pathways, in soil and water ecosystems. This project intends to employ novel channel glass biosensor chips containing arrays of DNA probes to characterize and monitor the response of soil microorganisms to exposure to genotoxic agents. The biochip device consists of a glass or silicon dioxide wafer containing miniature patches of densely packed pores of 1-10 μm diam., extending through and perpendicular to the wafer surface. DNA probes can be immobilized within individual porous patches at addressable sites across the wafer, to provide a microscopic array of unique nucleic acid hybridization sites. An array of surface-tethered oligonucleotide probes is called a genosensor. The main risks (technical challenges) associated with the project include the requirement to extract intact (undegraded) RNA from environmental samples and the low abundance of soil microorganisms deep below the surface. Feasibility studies will directly address these critical issues in order to define the operational limitations and utility of the approach.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Selection of oligonucleotide probes targeted to at least 20 stress response and DNA damage-inducible genes predicted to be relevant to cleanup of military sites
- Determination of detection sensitivity and dynamic range of stress response genosensor, using RNA extracted from laboratory-treated bacterial cultures
- Fabrication and initial testing of "ASOF" genosensors containing 500 probes of length optimized for mRNA profiling in cultured bacteria
- Design of strategies to assess and compensate for effects of site-to-site variation in microbial communities on gene expression profiles
- Multi-gene analysis of genotoxicity response in mixed bacterial culture exposed to at least one military-relevant compound
- Multi-gene analysis of genotoxicity response in a model soil microcosm exposed to at least one military-relevant compound
- Experimental evaluation of a "spiking" strategy using a model soil microcosm, for dealing with the low abundance of microorganisms in a deep subsurface environment
- Evaluation of the direct detection (without PCR) of several mRNA species from cultured bacteria, using the tandem hybridization approach in channel glass
- Fabrication and initial testing of 1500-probe ASOF chips for mRNA profiling in one species of bacterium exposed to one genotoxic agent of military relevance
- Initial studies of gene-targeted and ASOF chips applied to RNA extracted from field-derived soil/sediment samples at WES
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Hazard/Risk Assessment of Military Unique Compounds (MUCs)

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Army may be spending unnecessary funds during remediation for overly conservative clean-up target levels. Hazard and risk assessment methods are required to determine appropriate exposure and toxicity levels during production, storage, transportation, use and disposal of military unique compounds (e.g., RDX), their breakdown products, and depleted uranium.

Performance standards and guidance must also be developed that are specific to these compounds, consider the source and manner of contamination, the means of migration, receptors, and future land uses. These performance standards and guidance are necessary in order to develop accurate risk-based clean-up levels and sound remedial action decisions. The Army's 1996 DSERTS revealed that \$45.7 million was requested for in-situ treatment of explosives. It is believed that some remedial actions required treatment to overly conservative target levels. If sound hazard/risk assessment tools are available to analyze the actual risk from these compounds, less stringent clean-up target levels may be accepted with significant cost savings to the military.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop version 1.0 of the Risk Assessment Modeling System
- Demonstrate linkage of fate and transport of explosives with a screening level effects assessment model
- Reduce the time and costs to conduct risk assessments by 20%

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: Using Mode of Action to Assess Health Risk for Mixtures of Chemical/Physical Agents

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Mixtures of carcinogenic chemicals are a major problem in groundwater plumes and soils on Department of Defense (DoD) and Department of Energy (DOE) facilities. While there is frequently data available for interactions between chemicals to judge risks from short-term exposures, data that describes how interactions influence the development of cancer are very rare. This is largely because of the high costs associated with conducting complex interaction studies over the lifetime of experimental animals. Therefore, it is important that the limited resources that are available for studying interactions be directed towards the development of general principles that can be applied to a wide variety of circumstances. The hypothesis this project intends to test is whether classifying the modes of action represented in a mixture and knowledge about the dose-response characteristics involved in eliciting a particular mode of action will provide a simpler and more accurate means of predicting the hazards that the mixture poses over a range of exposure situations. Whereas the number of chemicals present in the mixture may be large, the number of modes of action responsible for these effects is small. Each mode of action may have dozens of mechanisms that might contribute to changes in cell birth/death processes, but establishing mechanisms for every chemical is very expensive. The modes of action represented by the three chemicals proposed for study are general to chemical carcinogenesis. Thus, the approach that would result from proving the project hypothesis should be broadly applicable to any mixtures of chemical and/or physical causes of cancer. The top seven chlorinated hydrocarbon solvents found on DOE facilities produce liver cancer by non-genotoxic mechanisms. Two others are clearly genotoxic. Therefore, all modes of action are represented among these compounds. The occurrence of the genotoxic compounds is much less frequent and generally at much lower concentrations than the first seven compounds. Their cleanup levels are less controversial because it is difficult to refute low dose linearity in response for such chemicals and their concentrations rarely exceed drinking water standards of the Environmental Protection Agency (EPA).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete in-life single/dual compound prediction study
- Complete tumor diagnosis
- Initiate tumor diagnosis
- Complete tissue block/sectioning
- Complete preliminary statistical analysis on tumor size data to identify major interactions
- Begin to input data for model development
- Begin statistical analysis of tumor size/number data
- Complete immunohistochemical evaluation
- Submit Annual Report to SERDP
- Complete immunohistochemical staining
- Complete model development
- Complete statistical analysis
- Initiate immunohistochemical staining

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

CLEANUP:

SEDIMENT REMEDIATION

PROJECT SUMMARY

TITLE: Assessment and Prediction of Biostabilization of PAHs in Sediments

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objectives of this research are to identify those factors affecting biostabilization of Polycyclic Aromatic Hydrocarbons (PAHs) in sediments and to develop the technical basis for enhancing natural recovery processes for the biotreatment of PAHs in dredged material. The key questions to be addressed in this research are: (1) Where exactly at the microscopic scale do PAHs reside on aged sediments?; (2) How are the microscopic-scale locations of PAHs on sediments dependent on sorbent carbon location and type?; (3) What are the distribution of binding activation energies for desorption of PAHs from sediment particles, and how does this correlate with information on PAH association with sorbent carbon type?; (4) How does the effectiveness of bioslurry treatment of dredged sediments depend on the locations and associations of PAHs with sorbent organic matter and distributions of binding activation energies with respect to removal of specific compounds, the fraction of labile and resistant PAHs, and the toxicity of residual PAHs?; and (5) How may knowledge of the association of PAHs with sorbent carbon type and location, and distribution of binding activation energies, be used to assess and predict the overall performance of bioslurry processes for biostabilization of PAHs? This research will assess the fundamental character of the binding of PAHs at the microscopic scale in parallel with bioslurry treatment and ecotoxicological testing, to show how the nature of PAH association with sediments related to biostabilization, achievable treatment endpoints, toxicity, and bioavailability. The work will explore mechanisms controlling PAH sequestration using novel spectroscopic techniques to examine at the microscale the distributions and associations, and binding energies of PAHs in sediments.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Completed the development of Green Fluorescent Gene construct for visualization of PAH availability to microorganisms
- Investigate complementary analytical techniques to Assess SOM Type and Location
- Perform thermal desorption MS analyses to Evaluate Desorption Energy Characteristics
- Use data from the above tests to develop micro-scale mechanistic understanding of the sequestration of PAH homologs and their bioavailability
- Conduct biostabilization experiments in microcosms and bioslurry reactors with contaminated sediments from confined disposal facilities (CDFs)
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Biogeochemical Fingerprinting for Sediment Management

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This program will demonstrate the utility of using site-specific biogeochemical fingerprinting of contaminated sediments to streamline the progress from site assessment to site closure at Installation Restoration and BRAC offshore sites or for dredge permitting. Often at offshore sites, data collected in the R/I phase may not provide necessary information to make an informed management decision. To resolve this problem, this project will work towards (1) providing site owners with the tools to rapidly determine what sediment management approaches are feasible for contaminated sediments at their sites, (2) streamlining the decision process for sediment management, and (3) bridging the gap between remedial investigations and feasibility studies by providing specific information on remedial and sediment management options.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Conduct bench test assays
- Identify 3 sites for demonstration
- Collect samples at site 1 and apply biogeochemical fingerprinting analyses on sediments
- Prepare report on site 1
- Deploy site 2
- Validated utility of approach at Alameda NAS (Site 1) and provided data to site owners for use in site management decisions

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Enhanced Alternative and In-Situ Remediation Technologies for Explosives/Organics in Soil and Sediment

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will pursue the following objectives:

- Engineering enhancements to natural attenuation and bio-augmentation methods.
- Current remediation technology for explosives contaminated soils requires dig and haul at a cost ranging from \$100-500/ton.
- Low levels of contamination over large areas; beneath ground surface structures/obstacles.
- In-situ treatment technology will reduce costs to less than \$75/ton.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Demonstrate exsitu biotreatment and physical separation/extraction technologies for explosives and organics in soil

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: Integrated Sediment Characterization

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Navy dredges millions of cubic yards of sediments every year throughout the United States in order to maintain waterways and berthing areas. If those sediments are contaminated, they must either be disposed of in a Contaminated Disposal Facility (CDF) or treated prior to discharge at sea. The latter is costly and the former simply delays potential future liability. This task will assess the Navy contaminated sediment problem, identify technology gaps, and prioritize and select future S&T research needs.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Conduct Sediment assessment workshop
- Review and select potential technologies for incorporation into assessment
- Develop technology transfer process and form inter-service working groups
- Issue Initiation Decision Report (IDR)

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: QWIKLITE for Sediment (QWIKSED)

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop a rapid and cost effective bioassay for conducting contaminated sediment toxicity tests that will provide a faster response time and cost less than conventional toxicity procedures. The bioassay system can also be used as a rapid screening tool as it can be run in as few as 4 hours and is simple to run.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Conduct Demonstration at Alameda NAS
- Conduct Demonstration at Pearl Harbor
- ASTM Standard Amendment
- Prepare Final Report
- Correlate QwikSed technology with conventional toxicity tests
- Validate the correlation of the QwikSed toxicity measurements to chemistry profiles for rapid screening scenario
- ASTM Standard Guide for Conducting Toxicity Test with Bioluminescent Dinoflagellates E1924-97 published
- QwikSed Toxicity test unit commercialized by SeaLite Instruments, Inc, Ft. Lauderdale, FL

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Recycling of Contaminated Dredge Sediment

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this effort is to evaluate Cement-Lock technology for recycling contaminated dredge sediment and other potential waste streams such as contaminated soil, into salable product without generating secondary wastes.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Evaluate Navy contaminated sediment disposal projections in Puget Sound, WA and Pearl Harbor, HI regions to assess economic viability of Cement-Lock technology deployment

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

CLEANUP:

SITE CHARACTERIZATION AND MONITORING

PROJECT SUMMARY

TITLE: 3-D Imaging

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0605502F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this research and development project is to design and build a downhole sensor to depict the presence of non-aqueous phase liquids (NAPLs) in the subsurface. The image will be a composite of the responses from seismic and electromagnetic tomography from single borehole and borehole-to-borehole data.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Project milestones for FY 1999 included building the prototype downhole electromagnetic transmitter and receiver, and demonstrating the unit at a known NAPL site.

ANNUAL PERFORMANCE REVIEW: The device was successfully built in FY99, but delays during fabrication have pushed the demonstration into FY00 at no additional cost to the government.

PROJECT SUMMARY

TITLE: Direct Push Data Mapping and Monitoring Point Assessment

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603723F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The goal of this project was to validate the use of cone penetrometer to install monitoring points for long-term monitoring of groundwater quality.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Install wells using cone penetrometer technology (CPT)
- Sample groundwater
- Analyze results and compare to those of conventionally installed wells

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Environmental Field Assessment and Survey Tool (E-FAST)

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0605502F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this research and development project is to develop an expansion unit for handheld computers to provide additional PCMCIA slots into which multiple environmental sensors can be inserted providing a handheld site characterization tool. Software installed in the computer would allow a non-professional to complete a risk-based site characterization gathering all the information needed for a defensible, multimedia report or litigation.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Hardware and software development and fabrication

ANNUAL PERFORMANCE REVIEW: Mid-stream technology change caused delays in hardware and software development. Milestones will be completed in FY00 at no additional cost.

PROJECT SUMMARY

TITLE: Explosives Detecting Immunosensors

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The U.S. Department of Defense (DoD) has over 50 sites on the U.S. Environmental Protection Agency (EPA) Superfund list that are contaminated with explosives from munitions manufacture, storage, and demilitarization. Remediation of water and soil at these sites requires rapid, accurate analysis of field samples at the site and in the surrounding area. This ESTCP project demonstrates two immunosensors (the fiber-optic biosensor and the continuous flow immunosensor) for onsite screening and monitoring of explosives (TNT and RDX) in soil and water, and to gain certification and approval of both methods from EPA.

The fiber-optic biosensor and the continuous flow immunosensor, developed at the Naval Research Laboratory (NRL) in collaboration with Research International, will be employed at sites for the detection of TNT and RDX. Both sensors determine the level of contamination by measuring the proportional level of fluorescent activity caused by the introduction of the sample to the system. The fiber-optic biosensor employs a method in which contaminant molecules compete with fluorescent antibodies for a binding site on the fiber optic core. Any decrease in fluorescent activity caused by contaminants binding onto antibody sites corresponds to the level of contamination. The continuous flow immunosensor uses a method in which the contaminant molecules displace fluorescent antigens that are immobilized on a solid support. These displaced antigens are then detected and correspond proportionally to the level of contamination. Both biosensors are rapid (2–10 minutes per analysis), sensitive (low parts-per-billion concentration detection), and portable. In addition, both can analyze real-world samples such as ground, river, and bilge waters and soil leachates without sample preparation.

Water and soil samples from Umatilla Army Depot Activity and Submarine Base Bangor will be tested on site using both sensors. An independent laboratory using EPA SW 846 Method 8330 will also analyze split samples. The field demonstrations will validate whether the devices can be operated successfully by nontechnical personnel and whether they can reliably track contamination levels when compared to independent analyses.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Document Preparation
- Environmental Technology Verification Program (ETV) Pre-Demonstration analysis of water samples
- ETV Field Demonstration groundwater
- Final Report
- Draft Cost and Performance Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Horizontal Characterization/Monitoring Technology for DNAPLs

BUDGET ACTIVITY: 6

PROGRAM ELEMENT: 0630723F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will integrate off-the-shelf environmental site characterization sensors with horizontal drilling technology for performing real time measurement-while-drilling site characterization. The integrated system will then be demonstrated in various geologic environments.

ANNUAL PERFORMANCE OBJECTIVES FOR FY 99:

- Characterization of the membrane interface probe
- Selection of photo ionization detector (PID)
- Design of downhole components

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Improved Sediment Bioassays to Reduce False Positives

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to evaluate the natural or confounding factors which cause toxicity (false positives), optimize methods to measure or eliminate those factors, and to optimize and validate cost-effective bioassays which reduce or eliminate those problems. A prevalent problem in site assessment, particularly from bioassays of contaminated sediments, is “false positives” in bioassays, a toxic response caused by non-anthropogenic factors such as ammonia, grain size, sulfides, and natural toxins. Such false positives cause unnecessary and expensive studies and/or potentially expensive remedial actions at a site, that may not be necessary if the confounding factors had been identified.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Conduct field tests of Amphipods, Sea urchin, and QwikSed on sediments from various sites
- Modify POMFRET-LAC system to ameliorate “false positives”
- Evaluated a number of species for ammonia tolerance. Selected the most appropriate species to reduce the false positive toxicity effects of sediment. Demonstrated the use of this species at 2 Navy Sites
- Conducted laboratory tests to evaluate methods to reduce confounding factors such as ammonia. Completed ammonia correction calibration curve for selected species to remove ammonia interference

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: In Situ Radiation Detection Demonstration

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Department of Defense (DoD) and Department of Energy (DOE) have significant land areas contaminated with radionuclides, primarily by depleted uranium at various firing ranges. Current radionuclide survey techniques for land areas are labor intensive and lack radionuclide specificity. In addition, collecting soil samples for subsequent analyses is time consuming, expensive, and lacks comprehensive coverage of the area sampled. Such shortcomings result in a reliance on statistical justification for the number of locations sampled. Use of automated in situ survey techniques is gaining greater acceptance with regulatory agencies. However, automated techniques still lack radionuclide specificity, producing results that are gross indicators of the presence of radioactivity rather than the final soil concentration of the radionuclide of concern.

This demonstration will validate that in situ field readings can be presented directly in soil concentration units (pCi/g) that can be related to cleanup standards. To meet this objective the project will develop a computer-predictive model for calculation of static and scanning minimum detectable activity and specific calibration factors for radionuclides of interest when using in situ field detectors, such as large-area plastic scintillators or sodium iodide detectors. The acceptable scanning speed for in situ field measurements will be determined as related to soil-applicable cleanup guidelines and the instrument's sensitivity versus scan speed characteristics. At the same time, the response of the detector will be determined for the specific radionuclides expected in the contaminated area, so that the in situ instrument readings can be presented directly in soil concentration units. Using existing, proven detector technology, coupled with off-the-shelf Global Positioning System (GPS) technology, this project will improve capabilities of characterizing radioactively contaminated land areas and will improve specificity of data output. The data volume produced by this approach will be increased by several orders of magnitude over traditional site survey and sampling approaches. In addition, presentation of the survey results using standard Global Information System (GIS) techniques will enhance the credibility and understanding of the survey results by regulators and the general public. The developed isotope-specific instrument calibration factors will be validated through field tests at Kirtland Air Force Base, NM.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Provide project presentation to RAB
- Submit Draft Demonstration Plan
- Complete Unit Calibration
- Submit Final Demonstration Plan
- Initiate Field Activities
- Complete Field Activities
- Submit final report and cost and performance report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Integrated Field Screening for Rapid Sediment Characterization

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this effort is to demonstrate an integrated field-screening approach for assessment of contamination in marine sediment samples. Sediment samples can be screened for a number of metals using X-ray fluorescence (XRF). Organic contaminants such as PAHs can be screened by UV fluorescence (UVF). The QwikSed rapid screening bioassay is being developed under separate 6.4 level funding but will be integrated with the screening techniques discussed here to form an integrated screening package. Field-screening techniques can reduce the number of samples required for later laboratory analyses, yet provide improved understanding of contaminant distribution and the other sediment properties that ultimately control remediation options. The main benefit, however, is the reduction of the time and cost for later laboratory analyses. If a site can be rapidly delineated into areas of contaminated versus clean zones, then sampling for more costly laboratory measurements can be more efficiently planned. This would allow the number of laboratory samples required to characterize a site to be reduced, leading to faster and cheaper assessment of the site.

This project was cooperatively funded by the Navy and ESTCP in FY99 (see p. A-55).

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Conduct Field Demonstration of Screening technologies at Alameda NAS Sediment site
- Conduct Field Demonstration at 2nd Site (Pearl Harbor)
- Prepare Final Report
- Individual screening techniques were shown to have high correlation coefficient and low % false negatives
- Site demonstrations have shown that analytical costs can be reduced and a much clearer definition of contaminant distributions can be made to enable better remedial decisions

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Integrated Geophysical Multi-Sensor Detection of DNAPL Source Zone Identification

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to provide cost-effective three-dimensional (3-D) geophysical imaging of the geological control on Dense Non-Aqueous Phase Liquid (DNAPL) distribution and migration at different spatial resolutions and, at the highest available resolution, to directly image DNAPL. Specifically, the project intends to develop a three-fold approach to characterization of physical heterogeneity controlling DNAPL migration and the ultimate imaging of DNAPL distribution in the subsurface: (1) joint 3-D tomographic inversion of surface seismic refraction and electrical resistivity data to broadly delineate subsurface geology; (2) high-resolution joint 2-D/3-D crosshole tomography using downhole seismic and electrical sources and sensors in permanent 4-inch wells and/or temporary 2-inch boring; (3) utilization of the same downhole electrical sensors to perform IP tomography to image DNAPL with the geological constraints from the above two steps. This three-fold approach will provide new cost-effective, minimally invasive technologies for 3-D geophysical imaging of DNAPL without producing any secondary waste.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Seismic, DC Resistivity, and IP Equipment Evaluated
- Surface Seismic and Electrical Data Gathered
- Borehole Seismic, Resistivity and IP Data Gathered
- Evaluate Cap Coupling of DC Resistivity and IP
- Field Methods Developed
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Negative Ion Sensors for Real-Time Downhole DNAPLs Detection

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Location of the Dense Non-Aqueous Phase Liquids (DNAPL) sources and reliable estimates of their masses are crucial for cost-effective cleanup. No currently available method can accurately and efficiently define the subsurface distribution of chlorinated solvent DNAPLs. The objective of this project is to develop a Site Characterization and Analysis Penetrometer System (SCAPS) probe which can detect, locate, quantify, and determine the subsurface distribution of DNAPLs in the soil. The key probe elements are a heated membrane interface and a sensitive, fast-responding downhole detector. Performance objectives have been established as follows: sensor responsiveness to all common organochlorine compounds, vapor limit of detection of 1 ppmv, selectivity better than 5000:1 relative to fuel hydrocarbons, less than 3 second response time, and automatic operation as the probe is advanced by a cone penetrometer or Geoprobe. The research objectives are to characterize the existing Polytetrafluoroethylene (PTFE) membrane's time- and temperature-dependent permeability for chlorinated solvents, fuel hydrocarbons, water, and oxygen; identify, select, and evaluate promising alternative membrane materials; find the material transfer efficiency as a function of distance from the membrane, soil type, temperature, and moisture; and optimize sensor performance, reliability, and ease of operation. Three sensor approaches that exploit the high electronegativity of chlorinated compounds have been identified. They are thermionic ionization sources, a photoemissive electron capture detector (PE-ECD), and a photoemissive ion mobility spectrometer (PE-IMS). The former two will be investigated in this effort. Risk is relatively low because the heated membrane is already in commercial use and preliminary laboratory data have been acquired for the sensors.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Critical review of lab/field results to date
- Construction of ruggedized TID downhole prototype detector
- Identify test sites for field validation
- Updated performance goals
- Determine penetration rate influence on sensor performance
- Validated studies of downhole prototypes
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Nonintrusive Characterization of Dense Nonaqueous Phase Liquids Using Short-Lived Radiotracers in Partitioning Interwell Tracer Tests

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of the proposed research is to develop partitioning interwell tracer testing using short-lived radioisotopic tracers as an effective characterization technique for Dense Nonaqueous Phase Liquids (DNAPL) in the either the saturated or unsaturated zone. This technique can be viewed as the next evolution in partitioning tracer testing and offers significant benefits over currently available technologies. By injecting conservative and partitioning short-lived radioisotopic tracers into the subsurface and continuously measuring their presence in monitoring wells with moveable downhole detectors, the location and amount of DNAPL can be measured to a much greater extent than can now be achieved by any other method. The technical approach for this project is to develop the radiochemical techniques for making tagged tracers together with assembling suitable detectors. After the field prototype has been tested, the tracers and sensors will be used in a field application to further develop the method. The field testing will be guided by detailed fluid flow modeling, as will the interpretation of the field results. The tasks for this project are: 1) Detector and Logging System Development, 2) Tracer Selection and Radiochemistry Techniques, 3) Laboratory Testing, 4) Pre-Test Modeling and Field Test Planning, 5) Field Testing, 6) Inverse Modeling (Data Analysis), and 7) a Guidance Document.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Perform pre-test modeling
- Field test plan
- Initiate laboratory testing
- Develop tracer selection and radiochemistry techniques
- Perform detector development
- Perform field testing
- Pursue permits and approvals for field testing
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Portable SERS Instrument for Explosives Monitoring

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Monitoring for explosive compounds in support of groundwater remediation activities is presently both an expensive and time-consuming process. The purpose of this project is to demonstrate and validate the time and cost-saving performance of a portable Surface-Enhanced Raman (SER) instrument for groundwater and remediation process control monitoring.

The SER technique uses laser light scattering to detect explosive related compounds at trace levels in water samples. SER spectroscopy is a high resolution, vibrational method where each molecule produces a unique spectral fingerprint that can be used to differentiate it from other sample components. The SER method can also be performed on very small samples, often as little as a few microliters of water. These advantages make SER an excellent technique for the rapid analysis of explosives in environmental water samples. In this project, a portable SER instrument will be assembled and demonstrated in the field. The capability of the instrument for performing *ex situ* and *in situ* analysis of explosive-related compounds collected from groundwater monitoring wells and remediation process streams, and finally as an *in situ* analysis tool using the cone penetrometer, will be evaluated. In addition to demonstrating the technical performance of the SER instrument, the potential cost savings to end users will also be demonstrated and validated.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Contract Award to Applied Research Associates, Inc.

ANNUAL PERFORMANCE REVIEW: Met all performance objectives. Project initiated late in fiscal year due to delays in contracting.

PROJECT SUMMARY

TITLE: Quantifying In Situ Contaminant Mobility in Marine Sediments

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Marine sediments serve as a repository for contaminants from a wide variety of sources. The environmental risks posed by these contaminants are determined largely by the degree to which they remobilize into the environment. This project demonstrates an instrument adapted from deep-water oceanographic studies to directly quantify the mobility and bioavailability of contaminants in marine sediments. No other viable method is available for direct quantification of sediments as sources.

The Benthic Flux Sampling Device (BFSD) was adapted from a benthic flux chamber technology that was developed for oceanographic studies to determine the cycles of major elements and nutrients on the seafloor. The BFSD is an autonomous instrument for in situ measurement of flux rates of sediment contaminants like heavy metals (e.g., lead, mercury, chromium, zinc, and copper), polychlorinated biphenyls (PCBs), dioxins, and petroleum products. A flux out of, or into, sediment is measured by isolating a volume of water above the sediment, drawing off samples from this volume over time, and analyzing the samples for increase or decrease in toxicant concentration. Increasing concentrations indicate that the toxicant is fluxing out of the sediment. Decreasing concentrations indicate that the toxicant is fluxing into the sediment. The BFSD system performs autonomous collection of samples from a sealed volume at the sediment water interface during a period of 2 to 4 days, providing the basis for risk-based decision making and potential cost savings by measuring bioavailability of contaminated sediment, reducing cleanup requirements where contaminants are not remobilizing, evaluating the integrity of sediment caps, and documenting the actual contaminant contribution of sediments.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Pearl Harbor demonstration begins
- Draft Final Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Radon-222 as Natural Tracer for Monitoring the Remediation of NAPL Contamination in the Subsurface

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: One of the major obstacles preventing cost-effective cleanup of many Department of Defense (DoD) sites is the current inability to accurately locate and quantify residual nonaqueous phase liquid (NAPL) contamination. Monitoring NAPL remediation is desirable to quantify the extent of cleanup achieved and to verify the cost-effectiveness of the applied technology. Common tracer methods for estimating NAPL saturation require the addition of partitioning tracers to the subsurface and the creation of a flow field, such as a well-to-well test. The recently developed natural radon-222 (Rn) tracer method has the potential to provide a rapid, low-cost, and noninvasive routine-use method for quantifying residual NAPL saturation. Since Rn is already present in the subsurface due to the decay of radium-226, its addition is not required. In its simplest form, the method requires monitoring radon concentrations in subsurface fluids to evaluate the progress of NAPL remediation.

The method is based on Rn's high solubility in organic NAPL. In the absence of NAPL contamination, aqueous Rn concentrations reach background levels that depend on aquifer porosity and mineralogy. In the presence of NAPL, aqueous Rn concentrations are substantially reduced as the Rn partitions into the residual NAPL. The resulting 'Rn deficit' can be quantitatively correlated to the degree of NAPL saturation. Thus, it is possible to quantify the presence of residual NAPL and assess the effectiveness of remediation efforts by measuring the Rn concentration in groundwater produced from existing monitoring wells. The transport of Rn is also retarded due to the partitioning of Rn into the NAPL phase. Thus, Rn can be used as a natural partitioning tracer in dynamic transport experiments. The radon method will be evaluated at several DoD sites where NAPL contamination is being remediated. Once demonstrated and validated, an ESTCP technical protocol will be issued.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Contract Award to Oregon State University

ANNUAL PERFORMANCE REVIEW: Met all performance objectives. Project initiated late in fiscal year due to delays in contracting.

PROJECT SUMMARY

TITLE: Rapid Sediment Characterization

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Site assessment, compliance dredging, and monitoring activity associated with contaminated sediments at shoreside facilities represent a growing problem and an increasing expense for the U.S. Department of Defense. The use of field-screening techniques to guide collection of laboratory samples would allow more cost-effective and rapid site assessments of sediments. If a site's contaminant and toxicity levels can be rapidly delineated, the number of laboratory samples required to characterize a site could be reduced. This project will demonstrate a field-screening system that integrates chemical and bioassay screening technologies.

Integration of multiple sediment techniques in parallel will more thoroughly delineate the vertical and horizontal extent of site contamination. Simultaneously obtaining information on multiple chemical and biological parameters allows better delineation of problem areas. Sediments will be screened for metals (including cadmium, copper, lead, and zinc) using x-ray fluorescence and for petroleum products (such as polyaromatic hydrocarbons) using laser-induced fluorescence. Additional tools, including rapid screening bioassays for use with sediments (Microtox, QwikLite), will also allow simultaneous sampling. Predicting biological effects with bioassays is an essential component of environmental screening because it is not possible to screen for all possible contaminant chemistries. The IFRSC system will provide real-time data to allow onsite decision making. Real-time results will give site characterization investigators a valuable understanding of contaminant distributions so they can adjust field activity and ultimately control remediation options.

This project was cooperatively funded by ESTCP and the Navy in FY99 (see p. A-48).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Second Demo Plan (Draft)
- Second Demo Plan (Final)
- Demo conducted at Pearl Harbor Naval Complex, Hawaii

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: SCAPS Contaminant Transport Sensor System (DNAPL Source Zone Identification)

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to optimize and validate a direct push sensor using the Site Characterization and Analysis Penetrometer System (SCAPS) and a video imaging system package and associated data processing algorithms in order to generate real-time, high resolution maps of the transport characteristics and DNAPL source zones in the subsurface environment. One of the most difficult problems in site characterization and cleanup is the delineation of source zones for DNAPL products such as Trichloroethylene. It is very difficult to design effective remediation strategies without accurate knowledge of DNAPL source zones. In addition, uncertainty in the transport properties can lead to large errors in the predicted risk. The improved characterization/delineation of DNAPL source zones afforded by this sensor system can be used to select and optimize appropriate remedial strategies.

This technology was cooperatively funded by the Navy and ESTCP (see p. A-57).

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Conduct field validation of transport probe
- Fabricate/ Test large window probe for sensor system
- Develop enhanced Digital System
- Field test at Alameda NAS to delineate DNAPL pure product and information to optimize remedial design using steam enhance extraction system
- Post site assessment with the sensor system

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: SCAPS Heavy Metal Sensors

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will conduct side-by-side demonstrations and validations of three different penetrometer-deployed sensors for real-time, in situ field screening of heavy metals in soils: Fiber-Optic Laser Induced Breakdown Spectroscopy (FO-LIBS), Downhole-Laser LIBS (DL-LIBS), and X-ray Fluorescence (XRF). These demonstration and validation activities are intended to facilitate regulatory acceptance and to promote rapid technology transfer and commercialization of penetrometer metal sensor technologies. These goals will be achieved through validated comparison of sensor cost and performance data with conventional laboratory-based methods. Each metal sensor probe will be evaluated at four different sites. The sites will be selected to allow comparison of sensor performance under different hydrogeological conditions, with different assemblages of metal contaminants, and in different geographic regions.

The Site Characterization and Analysis Penetrometer System (SCAPS) uses a truck-mounted hydraulic cone penetrometer system to push an instrumented probe into the ground to depths of up to 100 feet or more. The FO-LIBS, DL-LIBS, and XRF heavy metal sensor probes have been configured for deployment on a standard cone penetrometer system. LIBS technology involves the analysis of the spectral emission from a plasma spark formed by focusing a high-energy pulsed laser on a small amount of sample material. FO-LIBS uses a fiber-optic line to deliver the laser light and generate the plasma. The DL-LIBS system uses a laser located in the probe head to generate the spark. Both systems then use a fiber-optic cable to collect the metal's emission signal and return it to a detector located in the truck's laboratory. The XRF sensor system uses a x-ray source located in the probe to bombard the soil sample with x-rays. Such bombardment excites various atoms present and induces them to emit fluorescent x-rays at well-known energy levels; these fluorescent x-rays are quantified using a detector located in the probe, and the metals in the soil are thus identified.

This technology was cooperatively funded by ESTCP and the Navy (see p. A-56).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Execute Site 2 demonstration/visitors day
- Complete execution of second demonstration

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Sonic CPT Probing in Support of DNAPL Characterization

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602202F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The goal of this project was to improve the suitability of the sonic cone penetrometer technology (CPT) for contaminant monitoring and cleanup on DoD sites. Sonic CPT can be used for characterization and monitoring of dense nonaqueous phase liquids (DNAPLs) by developing techniques that relate soil drive to soil properties and soil type. In addition, the project was to determine optimal operation parameters, integrate sensors and samplers, and develop techniques to cut through tough soils.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Demonstrate Sonic CPT at various sites to gain information on soil types/properties
- Develop Data Acquisition System to measure Sonic parameters
- Develop sensor technology
- Develop rotary system to cut through tough soils
- Develop eccentric mass system to optimize Sonic CPT operation

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Tri-Service SCAPS Demonstration/Validation

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This demonstration will validate the performance of Thermal Desorption and Hydrosparge Volatile Organic Compounds (VOC) samplers that are mounted on the U.S. Department of Defense (DoD) cone penetrometer system.

To lower the costs of site characterization and remediation, the U.S. Army, Navy, and Air Force are cooperating in the development, testing, and demonstration of the Site Characterization and Analysis Penetrometer System (SCAPS). The Thermal Desorption (TDS) and Hydrosparge VOC samplers will allow the truck-mounted SCAPS system to detect VOCs in soil and groundwater.

The SCAPS system uses a hydraulic cone penetrometer system to drive a probe into the ground to depths of up to one hundred feet. The Thermal Desorption VOC Sampler consists of an instrumented nose cone with a sampling chamber that can be opened to collect a soil sample for analysis. During the thermal desorption process, heat and gas are applied to the soil sample to collect VOCs, which are then transported to the surface. The Hydrosparge system applies heat and gas to a groundwater sample contained in its nose cone and transports any collected VOCs to the surface for analysis. In the SCAPS mobile laboratory, the volatile contaminants are interfaced with an ion trap mass spectrometer (ITMS), which measures VOC concentrations in real time. After a sample has been processed by either device, the sample chamber is cleaned and sterilized to prevent contamination of subsequent samples. This technology is being demonstrated at Aberdeen Proving Ground, Maryland, and McClellan Air Force Base, California, where system capabilities and effectiveness will be tested at solvent- and petroleum-contaminated sites.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Provide data to Cal EPA for review
- Select 2nd membrane interface probe (MIP) demonstration sites (May 1999)
- Revise demonstration plan for the DOE Savannah River Site and submit to ESTCP
- Perform 2nd MIP field demonstration at DOE Savannah River Site, Aiken, SC
- Submit first TDS data set to California EPA regulators for review
- Submit two additional TDS data sets
- Submit 1st demo plan for MIP demonstration at North Island Naval Air Station, CA

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

CLEANUP:
SOIL REMEDIATION

PROJECT SUMMARY

TITLE: Evaluation of In Situ Electrokinetic Remediation for Metal Contaminated Soils

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Numerous U.S. Department of Defense (DoD) activities, such as small-arms training, electroplating and propellant manufacturing have resulted in heavy metals contamination in soil at a number of installations. The military has a need to develop cost-effective remediation tools, and electrokinetics has been identified as a possible low-cost method for performing in situ extraction of heavy metals from soil. This project will demonstrate and evaluate the performance and cost-effectiveness of a large-scale electrokinetic system in the field.

Electrokinetics involves placing an anode and cathode in the soil and passing a low-voltage current between them. Four phenomena result from such microamperage currents: electromigration, electroosmosis, electrophoresis, and the creation of a pH front. These processes cause movement of metals and organic species toward the electrodes, at which point they can be removed as either elemental lead (plated to the electrodes) or in a saturated electrolyte solution.

This ESTCP field demonstration will take place at Point Mugu, California, on a one-half acre, tidal marsh site containing two waste pits. The unlined pits were used to dispose of millions of gallons of plating rinse water as well as photovoltaic fixer, organic solvents, and rocket fuel.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- End System Operation
- Demobilize Site
- Final Site Characterization Sampling
- Final Report and Cost and Performance Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Innovative and In-Situ Treatment Technologies for Soils Contaminated with Inorganics

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0601102A

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Inorganic contaminants enter soils from training activities, industrial operations, demilitarization activities and OB/OD. This Army cleanup program requires cost-effective technologies that target the inorganic contaminants (e.g., lead). As disposal restrictions become stricter, current approaches become increasingly more difficult and expensive to implement. Groundwater also may become contaminated from extracting metals from soils, and the removal of topsoil affects the stability of training lands.

Transporting hazardous wastes and residuals to off-site facilities for disposal is expensive and creates long-term liability for the Army. Innovative, cost-effective treatment technologies are required to eliminate the need for off-site treatment and disposal. These technologies should reduce the volume of the primary project waste stream that requires off-site disposal.

In-situ technologies also should be used whenever possible to prevent the requirement to excavate before treatment. Performance standards and cleanup target levels must be developed that consider the source of contamination, the risk of inorganics or byproducts leaching into the groundwater, the migration of contamination through sediment transport, the nature of the receptors, and future land use of the site.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Initiate development of screening and selection criteria for the use of plant and chemical treatment
- Conduct bench scale tests of instrumentation for in-process screening of inorganics

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: In Situ Chemical Reduction and Coprecipitation of Hexavalent Chromium

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Approximately 59 percent of U.S. Department of Defense (DoD) sites have groundwater impacted by heavy metals, of which hexavalent chromium is a major component. Plating and boiler operations and equipment repair and fabrication, among other activities, generate hexavalent chromium. Current remediation technologies to eliminate the problem primarily consist of plume containment methods rather than source control technologies. The purpose of this project is to demonstrate a cost-effective, rapid in-situ technology to eliminate dissolved hexavalent chromium by using both chemical reduction and ferrous iron precipitation to form an insoluble mineral precipitate this is stabilized in the subsurface.

Chemical reduction is a transfer of electrons between ions resulting in a lower valence state in the reduced element. Different valence states of an element have different reactive properties. Hexavalent chromium (Cr^{+6}) forms very soluble, non-reactive compounds in groundwater and is highly toxic to organisms and plants, whereas trivalent chromium (Cr^{+3}) forms insoluble mineral precipitates and is considerably less toxic. In this test, ferrous iron (Fe^{+2}) will be used to chemically reduce Cr^{+6} in groundwater, resulting in the formation of Cr^{+3} and Fe^{+3} . Dilute hydrogen peroxide and sulfuric acid will be used to destroy soluble organic chromium complexes, adjust groundwater pH to an optimal range, and displace Cr^{+6} from mineral surfaces. The Fe^{+3} rapidly precipitates as iron oxyhydroxide minerals and entrains the Cr^{+3} in the precipitate. Iron oxyhydroxide minerals are very insoluble in groundwater; thus the reduced chromium is permanently and irreversibly removed from groundwater and stabilized in the subsurface. Laboratory investigations indicate this process can result in substantial removal of chromium from solution.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Contract Award to Geo-Cleanse International, Inc.

ANNUAL PERFORMANCE REVIEW: Met all performance objectives. Project initiated late in fiscal year due to delays in contracting.

PROJECT SUMMARY

TITLE: Phytoremediation of Lead-Contaminated Soil

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Disposal and burning of scrap ammunition, use of firing ranges, rifle training and other activities have resulted in lead contamination of soils at many Department of Defense (DoD) installations. Current treatment options involve excavation and landfilling, soil washing, or immobilization through chemical treatment. These methods, however, do not destroy or reclaim the metals. Continued liability, long-term monitoring requirements, and land use restrictions dictate a need for less costly, more permanent treatment technologies. The purpose of this project is to demonstrate the technical and economic feasibility of using selected plants to remove lead from contaminated soil.

Phytoremediation is an alternative method for restoring soils contaminated with lead and other heavy metals by using plant species that accumulate high concentrations of metals in their tissues. Although insoluble in soil, lead can be coaxed into soil solution through the addition of soil amendments. Plant root systems then absorb the soil solution and transfer the metal ion to the plant vegetation. Successive plantings and harvests will continue to remove lead from the soil. The demonstration is being conducted at Twin Cities Army Ammunition Plant in Minnesota, at two locations with differing soil types. Selected species of plants associated with both warm and cool seasons will be planted. The effectiveness of the technology will be assessed based on lead levels in the soil after two seasons of phytoremediation. The assessment will include a cost analysis to allow a comparison with methods currently employed for remediation of lead contaminated soil. It will also allow an evaluation of the time required for phytoremediation to achieve an acceptable level of lead concentration.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Pre-Amendment Sampling Event Soil Amendments Added Cool Crop Post-Amendment Sampling Event
- Amendment Application
- Post Amendment Sampling
- Harvest cool crop
- Draft Interim Results/Guidance Document to team
- Draft Final Interim Results/Guidance Document to ESTCP
- Site Preparation
- Plant warm crop
- Pre-amendment sampling
- Amendment application
- Post-amendment sampling
- Harvest warm crop
- Plant cool crop

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

CLEANUP:

UXO CHARACTERIZATION AND REMEDIATION

PROJECT SUMMARY

TITLE: Dual Broadband Unexploded Ordnance (UXO) Detection and Discrimination

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Department of Defense (DoD) has millions of acres of land and over 1,000 sites at which buried unexploded ordnance (UXO) is a potential hazard to human beings and to the environment. Existing technologies for addressing this problem have proven insufficient, and technical advances are urgently needed to increase the efficiency of characterizing and remediating these lands. Magnetometers and electromagnetic induction devices have demonstrated substantial capabilities for detecting metallic subsurface objects. However, the U.S. Army Corps of Engineers estimates that about 70 percent of remediation costs are typically consumed by digging at "false-alarm" locations. That is, the detection systems find something in the locations, but what they discover are substances other than buried ordnance. The purpose of this project is to employ a new, broadband, fully polarimetric radar system to aid in discriminating subsurface ordnance from non-ordnance items.

The system being demonstrated employs a combination of traditional UXO detection methods and the new broadband radar technology. Once "hot spots" have been identified at a site by the lower frequency systems, more complete information is obtained at the higher radar frequency band being demonstrated. The new radar system, developed by the Ohio State University Electroscience Laboratory, consists of an orthogonal set of hornfed dipole antennas, controlled by a network analyzer over the ultra-wideband 20 MHz to 420 MHz. The nature of the feed permits a reliable input without distortion by ground loading. Rotation of the opposing dipole configuration produces complete polarization information, with sensitivity to target orientation, while providing orientation-independent characterization as well. Recording of the cross-polarized reflections avoids signal saturation by reflections from the ground surface or from other interfaces that are not of interest. In addition to providing orientation data, the radar's ultra-wideband spectrum facilitates inference of target depth and length. New special purpose algorithms will also be tested to infer target aspect ratio, gross shape, and some morphological detail (e.g. fins).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- OSU/ESL contract in place
- Setup lightweight dual-polarization HFB ground penetrating radar antenna and measurement system; make fully polarimetric via rotating platform
- Identify Site 1: list of proposed locations for first site, with each ranked as to suitability
- "Backyard" shakedown of equipment and procedures using known, emplaced example UXO and clutter targets
- Demo plan for first site, including prelim visit, site characterization and assessment

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Electromagnetic Induction and Magnetic Sensor Fusion for Enhanced Unexploded Ordnance (UXO) Target Classification

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The U.S. Department of Defense estimates that over 1,000 military sites are contaminated with unexploded ordnance (UXO). Automated, efficient survey technologies are required to characterize these sites so that required remediation can be undertaken. The ESTCP-funded Multi-Sensor Towed Array Detection System (MTADS) program has already demonstrated that detection systems using state-of-the-art sensors, precise navigation, and advanced data processing algorithms can routinely achieve UXO detection probabilities of greater than 95 percent. However, MTADS and other UXO detection systems continue to identify and classify a high number of non-ordnance fragments as ordnance. The U.S. Army Corps of Engineers, Huntsville Division estimates that 70 percent of the costs incurred during the remediation process are associated with digging non-ordnance (i.e. false positive) targets. This ESTCP project is evaluating the feasibility of combining the sensitivity to shape offered by electromagnetic induction (EMI) with the magnetometer sensors' proven location accuracy to dramatically reduce the false positive rate in UXO surveys.

The modified MTADS system deploys arrays of total field magnetometers and enhanced EMI sensors. Magnetometer anomaly characterization yields accurate target location and depth and an approximate size estimate (± 25 percent). The measured EMI signal depends on the target shape and orientation, especially the length-to-width aspect ratio of the target. This provides a useful method for distinguishing UXO (typical aspect ratio of 4 to 5) from ordnance fragments (aspect ratios less than 1 or greater than 10). A composite fitting algorithm will be developed to use data from both sensors to improve ordnance characterization and false target rejection. This algorithm accommodates the strengths and weaknesses of the individual sensors and weights the data from each sensor accordingly.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Submit draft test plan for TECHEVAL
- Initial implementation of new fit procedures completed
- Requirements Demonstration at NRL Blossom Point test site
- Submit draft test plan for Final Demonstration
- Final Demonstration

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Environmental Impacts to the Chemical Signature Emanating from UXO

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop a validated subsurface transport model that can be used to predict the spatial and phase specific concentration of chemical signature molecules derived from shallow unexploded ordnance (UXO) under the influence of specific environmental conditions. Other government programs are developing chemical detector platforms that can provide a separate unique signal to classify subsurface objects identified with existing geophysical systems. It is estimated that eleven million acres of land needs assessment to identify subsurface UXO - with costs estimated to be about \$1.4M/acre. The ranges where UXO can be found are distributed throughout the country where environmental conditions vary significantly. It is the hypothesis of this project that these environmental conditions will have a significant impact on the transport of chemical signature molecules from subsurface UXO to the surface before presentation to a chemical detector system. If through this systems analysis, one can show the ranges and/or combinations of environmental parameters that improve the transport of chemical signature molecules to the chemical detector system, and conversely, those that constrain this movement, end-users seeking to be better positioned to understand the merits and limitations when looking to deploy the chemical detector technology. The first task is to perform a sensitivity analysis of known input parameters in a one-dimensional analytical contaminant transport model, expand this model to assess two-dimensions to explore the surface area footprint from buried UXO, and modify an existing numerical simulation code (T2VOC) (precipitation/evaporation, temperature cycling, liquid diffusion) for use as the complete systems analysis tool.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete Footprint Analysis with 2-D model
- Complete post-shot ordnance source term
- Complete Lab Scale Experimental Design
- Compare T2TNT(bare ground) to 1-D Model
- Complete UXO Field Site Characterization #2
- Complete UXO Field Site Characterization #1
- Complete final lab-scale experiments
- Complete pre-shot ordnance source term
- Complete Initial Lab-Scale Experiments
- Complete T2TNT Soil-Plant-Air Interface
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Innovative Seismic System for Buried UXO Detection and Classification

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this effort is to investigate and develop a new Seismic Ordnance Detection System (SODS), which can improve the discrimination of unexploded ordnance (UXO) from clutter and thus reduce the number of excavations required during cleanup. The new seismic sensor will sense the mechanical properties of buried objects rather than their magnetic or electrical properties. The SODS system will operate in a manner similar to an active sonar system, with a mobile seismic array that sends broadband vibrational energy into the ground. These waves when they encounter an object with anomalous mechanical properties cause the object to rotate, translate, and to "ring," scattering energy back to the surface. These echoes will be received by an array of geophones and digitally recorded. The received signals are beamformed to locate the objects and to analyze the characteristic echo from the object. These characteristic echoes when used in conjunction with the magnetic and electrical response will more efficiently differentiate UXO from inert objects. After development and characterization of the performance of SODS, it can be used as one of a suite of sensors that can be tailored to specific site conditions and UXO types. This will significantly reduce survey and cleanup costs, especially in areas with high metal clutter or environmental degradation of the performance of other sensors. The technical approach for the investigation and development of the SODS consists of three phases: 1) performance of an initial feasibility study to analyze the practicality of seismic UXO detection using short wavelength shear waves; 2) development of a proof-of-concept SODS for testing; and, 3) evaluation of the proof-of-concept SODS in controlled testing. The system simulation of SODS will be based on computer modeling and field measurements of seismic wave propagation and noise. The second phase will utilize seismic sources and receivers that provide greater bandwidth, increased source level, and better earth coupling than are commercially available while engineering a practical mobile array of seismic transducers that can be used to efficiently collect seismic data. The third phase will include refining of the proof-of-concept system through diagnostic tests and analyzing detections of UXO culminating in an initial evaluation of SODS in multi-sensor tests and an analysis of false alarm reduction using the seismic data in a sensor fusion process.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Array-Mounted Receiver Design
- Subarray Construction and Testing
- POC Data Acquisition System
- Annual Progress Report FY 99
- Controlled Field Tests of POC System
- Seismic Source Design and Construction

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Laser Neutralization of Hazardous UXO

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Clearance of unexploded ordnance (UXO) is a necessary but hazardous function at many Department of Defense (DoD) sites. The traditional technique of detonating an explosive charge in close proximity to the UXO for disposal poses threats to the environment from introducing additional contamination to the soil, air, and water and also impacts indigenous wildlife. Handling, placing, and detonating the explosive charge in the vicinity of the UXO, which may contain anti-disturbance/area denial features, are hazardous for personnel, especially if there are a large number of targets, such as typically found with submunition clearance. A standoff tool to neutralize UXO from a safe distance, while not degrading the environment, is needed. The purpose of this project is to demonstrate and validate the use of standoff laser energy to neutralize UXO in an environmentally friendly way.

The U.S. Navy and SPARTA, Inc. have jointly developed a prototype laser neutralization system. The laser is a 500-watt diode pumped Nd:YAG laser mounted in a HMMWV as a mobility platform. All supporting subsystems are self-contained within the vehicle. An operator using a target-designating camera and a laser-beam director directs the high-power laser. The laser is directed to the target via a stabilized steering/pointing mirror. The target-designating camera is bore-sighted with the laser beam and packaged with the steering mirror on a precision gimbaled pedestal mounted above and behind the cab of an up-armored HMMWV. The system is projected to be able to heat certain UXO cases enough to cause detonation from a standoff range of hundreds of meters. Demonstrations will be held at Nellis Air Force Base (AFB) during normal range clearance operations and possibly at other ranges in the western United States.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Draft Demonstration Plan for the 500-Watt system to ESTCP office for review
- Final Demonstration Plan for the 500-watt system to the ESTCP office
- Initial demonstration of 500-watt system during range clearance operations

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Low Frequency Ultra-Wideband Synthetic Aperture Radar for Remote Detection of Surface and Subsurface UXO

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Currently, methods for detecting unexploded ordnance (UXO) involve laborious ground surveys that are slow, dangerous, and impractical for dealing with vast UXO-contaminated lands. Advanced technologies are required which are quicker, safer, and more cost-effective than current approaches. Synthetic Aperture Radar (SAR) is an advanced technology that offers significant potential for quickly and safely detecting UXO. The Army Research Laboratory (ARL) will use their precision measurement asset, called the BoomSAR, in the execution of this project. The BoomSAR is a fully polarimetric radar that operates across a 1-GHz-wide band, from 25 MHz to 1 GHz. This bandwidth contains low frequencies needed for ground penetration, while maintaining higher-frequency coverage for high-resolution imagery. The radar is mounted on a boom-lift that can operate at heights of 5 to 45 m while moving at 1 km per hour, allowing the radar to operate in a strip-map SAR mode. The goals of this project are: 1) to determine the applicability of low-frequency ultra-wideband (UWB) SAR for detecting and discriminating surface and subsurface UXO; 2) to refine and validate electromagnetic models that can be used to extrapolate UWB SAR performance to other environmental conditions (soils); and 3) to develop detection algorithms for separating UXO from clutter.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop Initial Set of Algorithms for UXO Detection
- Eglin Test Site Report
- Rehost Image Formation Software
- Continue Modeling of UXO Targets
- Conduct Data Collection at Eglin AFB
- Process Eglin GPR Data
- Process Yuma Proving Ground GPR Data
- Eglin Soil Analysis Report
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Matched Filter Processor for Detection and Discrimination of Unexploded Ordnance

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to demonstrate that an innovative automatic processing system which implements matched filtering and target attribute screening will improve buried unexploded ordnance (UXO) detection and false alarm rejection relative to procedures currently used in the field. The innovation lies in the implementation of optimal linear filtering in a threshold-based UXO detection processor and the application of Boolean logic to target attribute screening to rationalize the UXO/clutter discrimination process.

Current UXO detection practice involves experienced operators selecting anomalies from displays of survey data. There are always buried UXO targets which are too small or buried too deeply to be detected with current systems. Studies of visual signal detection, notably in the medical imaging community, consistently show that human operators do not perform as well as the optimal linear processor. The optimum linear detection processor is based on applying a threshold to the output of a prewhitening matched filter which compensates for any background correlation structure (prewhitens) and then correlates the data with the expected signal. It is optimal in that it maximizes the output signal to noise ratio. Optimal linear filtering has not been used for UXO detection. We will demonstrate that this innovation improves detection performance. We expect the proposed processor to enlarge the size-depth detection envelope by enabling the detection of weaker signals.

We will also implement screening procedures based on target attributes (size, depth, shape, etc.) determined from their magnetic and electromagnetic signatures. The objective is to discriminate between UXO and the false alarms due to metallic clutter that plague current detection systems. The individual screening criteria will be based on comparing the various target attribute values with threshold levels set by the user. We will combine the results of the individual tests using Boolean logic, allowing the user to specify which attributes to include in the logical sum.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Contract Award to AETC Inc.

ANNUAL PERFORMANCE REVIEW: Met all performance objectives. Project initiated late in fiscal year due to delays in contracting.

PROJECT SUMMARY

TITLE: Model-Based Data Fusion and Discrimination of UXO in Magnetometry and EM Surveys

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is the development of data fusion techniques for the best available existing sensor suites, to better allow discrimination between intact ordnance and the typical clutter associated with target and bombing ranges. Specifically, Naval Research Laboratory (NRL) intends to develop software techniques to allow discrimination of intact ordnance from Ordnance Explosive Wastes (OEW) using arrays of full-field magnetometers and time-domain electromagnetic sensors as the primary detection tools. These goals will be accomplished by developing new software for target identification, physical modeling, and probabilistic classification that uses the sensor data sets jointly. NRL's Multi-Sensor Towed Array Detector System (MTADS) will be the primary platform for which the software will be designed, although the work is applicable to any magnetic and electromagnetic array measurements and some aspects of the development are relevant to other types of sensor data.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Completion of EM Modeling Tool
- Completion of Mag Modeling Tool
- Submission of Annual Report
- Completion of Anomaly Picker
- Completion of Inverse Methods
- Model Calibration
- Probabilistic Classifier
- GUI Development
- Create Ordnance Clutter Field
- Link GUI to DAS
- System Performance Evaluation
- Completion of PCA Development

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Portable UXO Detection System

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: There are over 1,000 Department of Defense (DoD) sites in this country that require remediation for unexploded ordnance (UXO). The ESTCP-funded Multi-Sensor Towed Array Detection System (MTADS) has demonstrated that UXO detection rates approaching 100 percent can be achieved using towed sensor arrays. The U.S. Army Corps of Engineers, however, has estimated that more than 50 percent of the area at these sites is not amenable to survey using vehicular towed systems. In order to efficiently and economically survey all DoD areas, a portable detection and mapping system with the target detection capabilities of MTADS is required.

Three advantages of the MTADS system are sensitive, low-noise sensors, precise sensor location ability, and a state-of-the-art data analysis system. Each of these features will be incorporated into this project. The total-field magnetometers to be used are inherently low noise, but sensor motion relative to the ground introduces a substantial variation in output. A hybrid system involving a sensor-stabilizing wheel will allow replication of the excellent noise characteristics of the MTADS. In areas where Global Positioning System (GPS) location is possible, operation in the RTK mode gives sensor location to an accuracy of 2 to 5 centimeters. In areas such as heavily wooded fields where GPS reception is not possible, an alternative location system, such as acoustic or laser navigation, will be used. The MTADS data analysis system, with its proven performance in target location, depth prediction, and size estimation, will be adapted to seamlessly merge data from the vehicular platforms and the man-portable sensors.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- 4th Quarterly Report
- NRL Test Range completed
- 5th Quarterly Report
- 6th Quarterly Report
- Requirements Tests comp (Electromagnetic Manned Portable System - EMMS)
- 7th Quarterly Report
- Demonstration (both systems)

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Processing Techniques for Discrimination Between Buried Unexploded Ordnance and Clutter Using Multisensor Array Data

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project addresses the issue of discriminating between buried unexploded ordnance (UXO) and clutter in the context of environmental cleanup. In spite of the recent advances in UXO detection performance, false alarms due to clutter (signals incorrectly diagnosed as having been caused by UXO) remains a serious problem. With traditional survey methods, the Army Corps of Engineers finds that 85-95% of all detected targets are not UXO. Since the cost of identifying and disposing of UXO in the United States using current technologies is estimated to range up to \$500 billion, increases in performance efficiency due to reduced false alarm rates can result in substantial cost savings. The goal of this project is to develop a reliable method for discriminating between buried UXO and clutter. Our approach is to build on existing proven techniques which exploit differences in shape between ordnance and clutter by including the effects of other distinctive properties of ordnance items (fuze bodies, driving bands, fin assemblies, etc.). Our experience is that these attributes correspond to distinctive signatures in magnetic and electromagnetic induction sensor data. Current research activities are directed towards exploiting differences in shape between ordnance and clutter with commercially available sensors. In this project we will systematically explore the performance improvements which are realized when additional distinguishing target attributes are included in the discrimination process.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Measure and analyze UXO and baseline spectra
- Determine ground & competing effects
- Evaluate UXO signature content
- Develop baseline model
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Statistical Signal Processing with Physics-Based Models: Multi-Sensor UXO Detection and Identification

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Several sensor modalities are currently being explored for the detection and identification of surface and buried Unexploded Ordnance (UXO). These include electromagnetic induction (EMI), magnetometers, radar, and seismic sensors. These sensors experience little difficulty detecting the UXO, thus detection does not create the bottleneck that results in the high cost of remediating sites. The primary contributor to the costs and time associated with remediating a UXO contaminated site is the high false-alarm rate associated with each of the sensors when operated individually. In this project, the team will investigate the phenomenological aspects of the UXO detection, location, and discrimination problem using EMI, radar, seismic, and magnetometer sensors. The fundamental insight garnered by characterizing the underlying physics will be transitioned into high-performance sensor fusion and signal-processing algorithms for enhanced detection, location, and discrimination of buried UXO under a wide range of environmental conditions. The technical approach will employ synergistic research activities in modeling, signal processing, and sensor fusion. The researchers will perform phenomenological modeling of wave propagation and scattering for ultra-wideband (UWB) radar, seismic, and EMI sensors. The phenomenological studies will be performed in collaboration with SERDP-supported sensor-development programs underway in these areas (at NRL, ARL, and BBN). The previously developed models will be extended to allow arbitrary numbers of soil layers, arbitrary target shape and orientation, and to accurately account for all interactions. The use of these models will quantify the target types, depths, and soil conditions for which radar is an appropriate sensor. These models of the wave physics, coupled with models of target, clutter, and environmental uncertainties, will be incorporated into a statistical signal processing framework, thus novel, state-of-the-art optimal detection and identification algorithms will be developed for each sensor. Bayesian algorithms, which provide the optimal solution to detection and identification problems, will be investigated along with an algorithm based on a Hidden Markov Model formulation which is specifically suited for classification using data from multiple aspect angles. Finally, the researchers will develop sensor-fusion techniques that simultaneously exploit the richness and diversity of the phenomenology underlying multiple sensor modalities.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Seismic Modeling of Targets and Shells
- Model-based processing for BoomSAR
- Bayesian and HMM processing of NRL EMI & magnetometer data
- Seismic modeling of targets with shells
- EMI for large ordnance
- BoomSAR, targets at arbitrary orientation
- Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Unexploded Ordnance (UXO) Identification and Discrimination

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: In its 1996 UXO Report to Congress, the Army said 72 installations have identified 531,167 acres known to have UXO contamination and 940,438 acres of suspected contamination. Approximately 600 formerly used defense sites (FUDS) also have potential UXO contamination.

Survey and land management plans, aerial photography, and historical records often help identify potential UXO sites, and magnetometers and ground-penetrating radar help identify small-quantity UXO locations. These technologies are very expensive, however, and often cannot distinguish accurately between UXO and exploded ordnance and scrap metal masses in historical and current ranges, impact areas, landfills, underground storage locations, open burning and open detonation, and shallow and deep water sites.

USACE-Huntsville reports indicate that average surveys cost \$5,433 per acre (survey and mapping) to a depth of 4 feet. Many times, UXO-contaminated sites may remain unremediated and result in groundwater contamination from leaching and loss of the use of the area. Quick wide-area screening and footprint reduction technologies are needed to identify high-risk areas of a site for cleanup.

UXO identification and discrimination is important to disposing of explosive ordnance, site remediation, and clearing active ranges. Target discrimination technologies must be developed that are not intrusive, accurately identify UXO from scrap and shrapnel, and identify the configuration and type of ordnance. The development of identification and discrimination technologies is critical to increasing the safety of removal, designing appropriate removal operations, and decreasing removal costs.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Continue multi-sensor UXO data collection
- Construct advanced sensor fusion/analysis algorithms

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: UXO Discrimination by Mid-Frequency Electromagnetic Induction

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will perform basic research on sensor development, sensor utility, and signature possibilities in the uncharted 25 kHz – 300 kHz Medium Frequency - Electromagnetic Induction (MF-EMI) electromagnetic frequency band, for induction sensing of buried Unexploded Ordnance (UXO). The goal is to provide enhanced discrimination of ordnance from non-ordnance, and thereby reduce false alarm rates during field surveying. This will be accomplished by innovative instrumentation development in the MF-EMI band, in tandem with new modeling work. Technical objectives for this project include: 1) Perform lab measurements of soil electrical properties, including seasonal effects, for samples relevant to UXO sites in order to quantify expected subsurface signal loss rates; 2) Extend and verify suite of computer programs to achieve rigorous 3D solution of the physics of response by non-idealized UXO and non-UXO targets in realistic environments in this frequency range; 3) Produce high fidelity simulations in time, space, and frequency domains of the response by a wide range of specific UXO morphologies and dispositions, and by common non-UXO targets (fragment clusters, tin cans, open shapes, etc.) in realistic environments; 4) Obtain measured induction responses for array of UXO and non-UXO targets, using technology to be developed and exploiting existing data bases where possible; and, 5) Use all of the above to identify distinctive UXO signature behaviors, and their discernibility relative to the environment, for combination with those being obtained in frequency ranges both above and below 25 KHz - 300 KHz.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Design acquisition system & coils
- Knowledge inventory, estimation in gaps
- Compute limiting cases
- Extend frequency range
- Startup assessment, Go/No recommendation
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

CLEANUP:

OTHER

PROJECT SUMMARY

TITLE: Development of Simulators for In-Situ Remediation Evaluation, Design, and Operation

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The ultimate goal in remediation modeling is to minimize remediation costs and environmental and human risks while maximizing cleanup. Toward this end, the general goals of this project are: (1) to develop reliable simulators for promising technologies of interest to Department of Defense (DoD), Department of Energy (DOE), and the regulatory community, and (2) to provide efficient access to multiple remediation simulators through a common user environment amenable to multi-disciplinary cleanup teams. A common, graphical user environment has been developed for these simulators; it is the DoD Groundwater Modeling System (GMS). The GMS provides conceptualization, parameterization, visualization, and animation capabilities. Additionally, GMS extensions, either ongoing or planned, will provide capabilities for conducting remediation, uncertainty, optimization, and cost analyses. The primary technical objectives of this project are to: (1) develop/enhance state-of-the-art remediation simulators for the following technologies: in-situ bioremediation; surfactant-enhanced bioremediation; electrokinetic-enhanced bioremediation; electrokinetic-enhanced mobilization of metals; natural attenuation of petroleum hydrocarbons; natural attenuation of explosives; in-situ chemical treatment; surfactant/cosolvent flushing to recover Non-Aqueous Phase Liquids (NAPLs); soil vapor extraction; and air sparging; and (2) verify these simulators against available laboratory and field data; and (c) incorporate these simulators into the GMS to provide DoD, DOE, and other users with the computational ability to assess the tradeoff between environmental risk (cleanup level) and cost-effectiveness for a variety of cleanup technologies prior to their implementation. Technical risk issues involve: (1) uncertainty regarding key processes in complex remediation technologies; (2) the scarcity of experimental or field data for innovative technologies; and (3) the general adequacy of differing computational resources on which to run complex models efficiently. Leveraging against the new Common High-Performance Scalable Software Initiative and Army High- Performance Computing efforts will address several of the high-performance computing issues associated with simulator development and execution.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Publish users manual and documentation for SEAM3D(WES, contractor)
- Complete advanced NAX simulator code development
- Complete implementation of UTCHEM in GMS for flushing technologies (contractor and WES)
- Complete engineered bioremediation simulation verification using SEAM3D (WES)
- Complete NATS simulation verification of NA using SEAM3D (AL/EQ and contractors)
- Conduct training course on UTCHEM (WES, contractor)
- Update UTCHEM users manual and documentation (WES and contractor)
- Complete cosolvent flushing simulation verification using UTCHEM (WES)
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: In-Situ Clay Formation: A New Technology for Stable Containment Barriers

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: A new type of containment barrier with a potentially broader range of environmental stability and longevity could result in significant cost-savings to the Department of Defense (DoD) and Department of Energy (DOE). This project intends to precipitate clays in-situ in porous geologic materials by building on the technologies that exist for colloidal or gel stabilization. Unlike colloidal or gel barriers, however, a precipitated-clay barrier does not require saturated conditions to be functional. Thus, it can be emplaced without loss of performance in the vadose zone as well as areas with fluctuating water tables. Clays have the advantage of being geologically compatible with the near-surface environment and naturally sorptive for a range of contaminants. The precipitation of clays in-situ in soils and sediments should result in (1) reduced permeability and hydraulic conductivity and (2) increased mechanical stability through cementation of soil particles. By analogy with natural diagenesis in sedimentary rocks, the researchers intend to engineer "artificial" lithification in soils and sediments. Unlike natural diagenesis, however, the time-scale for clay growth will be accelerated greatly from more than tens of thousands of years down to a few weeks. The technical approach is multidisciplinary and involves plans to: (1) confirm published results suggesting that clays can be precipitated in a few weeks to months from aqueous gels; (2) design an optimal gel composition that will maximize clay yield and crystallization rate, while maintaining injectability into porous soils and sediments; (3) test the barrier formulation in laboratory experiments; and, (4) test the method in a field experiment. The critical key step in developing the new barrier technology will be to successfully optimize the formation of clays from aqueous gels under ambient conditions. Therefore the first year of the project will be focused on this step. However, researchers will also initiate the laboratory experiments and measurements (flow properties and mechanical stability) in order to address technical details that may arise with the materials or experimental design. Gel composition will be designed using approaches taken from the literature involving reactions and additives known to accelerate clay formation. Emphasis will be placed on characterizing the clay with respect to quantity, composition, and crystallinity. Emplacement of gels in laboratory tests will emulate field technologies such as permeation and jet grouting, and soil-mixing.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Selection of optimal set of gel compositions based on laboratory work to date to refine for barrier material
- Characterization of barrier materials with respect to gas permeability and hydraulic conductivity
- Completion of compressive strength tests of clay-cemented materials
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Integrated Biotreatment Research Program: From Flask to Field

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop a set of "realistic" biotreatment processes for the cleanup of several classes of contaminants at Department of Defense (DoD) sites. A single, panacea technology for each contaminant group that can be used at all DoD sites will not be obtained. All treatment processes have technical and economic limitations, and part of the experimental process of this program will be to define these limitations. The technical approach of this project will be to continue to investigate a variety of promising biotreatment processes at the bench and intermediate scale. The experiments in this program will be directed toward four major research areas: 1) biological treatment of explosives, 2) chlorinated solvents, 3) polychlorinated biphenyls (PCB), and 4) polycyclic aromatic hydrocarbons (PAH). The planned experiments represent up-to-date techniques with the potential for reducing treatment costs at DoD sites. In some cases, members of this consortium have developed the concepts under investigation. In other cases, other concepts that indicate promise were taken from current literature and professional affiliation. The technical approach and processes under development have the potential to be fielded within a reasonable amount of time. This approach will ensure that the DoD will have more cost-effective remediation technology within a time frame required for DoD site remediation activities.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Technical Advisory Committee (TAC) Spring Meeting to Evaluate Consortium Program/Specific Investigations
- Complete preliminary evaluation of electrically activated reductive dechlorination
- Complete evaluation of enhancement of PCB biodegradation
- Complete preliminary field evaluation of solvent-extraction-residual bioremediation
- Complete economic analysis and proof-of-concept of intermittently mixed bioreactor for enhancements in in-situ hPAH biodegradation
- Complete intermediate scale evaluation of enhancement in hPAH biodegradation by bioaugmentation
- Complete proof-of-concept evaluation for integrated chemical-biological treatment of TNT contaminated groundwater
- Bioconsortium Annual Meeting
- TAC Fall Meeting to Review FY99 Execution Plan
- Complete intermediate scale evaluation of bioremediation of DNT-contaminated soil
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: National Test Site Location - Dover AFB

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This National Environmental Technology Test Sites (NETTS) National Test Location, which is managed by the Air Force Research Laboratory, provides test sites for the application of characterization and remediation technologies to soil and water contaminated by chlorinated solvents. Its centerpiece is the Groundwater Remediation Field Laboratory (GRFL). The GRFL consists of isolated, well-monitored, in-situ controlled release test cells, in which mass-balance studies of the fate, transport and remediation of Dense Non-Aqueous Phase Liquids (DNAPLs) may be performed, weather protection, office space and a small analytical laboratory. Operations consist of long-term monitoring of the site, as well as project support to include injection of the constituent (Trichloroethylene primarily), demonstration of innovative technologies, and disposal of a minimal amount of waste from the tests. The GRFL program consists of construction of a maximum of five test cells spaced approximately 50 feet apart and constructed and operated in a way to minimize the potential for environmental contamination. Basic design consists of interconnected, steel barrier piling sections (2 feet width) forming a rectangular pattern (test cells will range in size up to 1800 square feet). By driving the sheet piling 3-5 feet into the clay aquitard (approximately 30 - 40 feet from the surface), a coffer is formed which prevents vertical and lateral migration outside the confines of the box. There is an additional secondary containment coffer surrounding the primary coffer, which is similarly sealed at the bottom and at each joint. The annulus between the cells is filled with water to produce an inward hydraulic gradient. The annulus and inner cell are continuously monitored for leakage. There are both upgradient and downgradient monitoring wells outside the secondary coffer. Other sheet pile designs to be considered include geomembrane and grout type barriers. Risks are minimal for the program as designed and can be controlled.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Permeable Reactive Barriers (Funnel & Gate Technology) - SERDP
- TCE Remediation of Soil and Groundwater (DSU) - HBCU
- Biological and Colloidal Transport of Solvents in Reactive Barrier (UConn) - AFRL
- Bioaugmentation For Anaerobic Dechlorination RTDF
- Effect of Heat During In-Situ Remediation on the Dynamics and Activity of Soil Microorganisms - HBCU
- Numerical Simulation of DNAPL Behavior - AFIT
- Intrinsic Bioremediation - RTDF
- Bioenhanced In-Well Vapor Stripping of TCE - SERDP
- Long Term Performance of Permeable Reactive Barrier - AFRL
- In Situ Cometabolism of TCE Using Butane and Butanol (Envirogen) - SBIR PhII
- Innovative Field Portable Characterization and Monitoring Technology - RCI
- Enhanced Source Removal - six demonstrations - SERDP
- Jet-Grouted Thin-Diaphragm Barriers (Phase II) - DOE
- Cometabolic Bioventing of Chlorinated Solvents - RTDF/EPA
- Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: National Test Site Location - McClellan AFB

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The National Environmental Technology Test Site (NETTS) program goal is to enable efficient demonstration of candidate detection, monitoring or cleanup technologies, either on an individual basis or in parallel with similar projects, under representative hydrological and climate regimes as found at many contaminated sites in the Department of Defense (DoD). Current environmental cleanup technologies are costly, slow, and largely ineffective. The NETTS program will provide test beds for research to fully understand the mechanisms in proposed treatment processes. The NETTS National Test Location at McClellan Air Force Base (AFB) provides test sites to investigate technologies for treatment of unsaturated soils and extracted soil-gas contaminated with chlorinated solvents, as well as ex-situ treatment of contaminated groundwater. As part of its cleanup effort, McClellan AFB has been well characterized. As a NETTS test location, McClellan AFB provides a well-characterized demonstration site for applied research, demonstration, and evaluation of promising cleanup and monitoring technologies. McClellan AFB currently has four operational and two planned Soil Vapor Extraction (SVE) Systems. All systems have dedicated utilities adjacent to them allowing for convenient slipstream demonstrations. McClellan AFB's groundwater treatment plant currently services 23 extraction wells. The SVE systems and groundwater treatment facility provide opportunities for demonstrating in-situ and ex-situ techniques for remediating soils and groundwater contaminated with solvents. There are more than 375 groundwater monitoring wells located on and around McClellan AFB.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Site infrastructure Maintenance
- Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: National Test Site Location - Port Hueneme

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of the Navy Construction Battalion Center (CBC) National Environmental Technology Test Sites (NETTS) National Test Location (NTL) at Port Hueneme, CA, is to support demonstration of systems for characterizing and remediating soil, sediments, and groundwater contaminated with fuel hydrocarbons and/or waste oil. It provides test sites to investigate both ex-situ technologies for treatment of soils and in-situ technologies for groundwater contaminated with fuel hydrocarbons. The Test Location Manager (TLM) at CBC, Port Hueneme will provide programmatic, infrastructure and technical support to NETTS for fuel hydrocarbon and waste oil characterization and remediation demonstrations. Programmatic support will include integration of the following: (1) Quality Assurance/Quality Control (QA/QC) procedures, (2) test protocol guidance, (3) demonstration reporting format, and (4) environmental setting, cost-and-performance data retrieval guidance. Infrastructure and its management (operation and maintenance) will include: (1) monitoring wells, (2) in-line sensor network, (3) ex-situ treatment facility with hazardous material handling capability, (4) utilities, (5) contaminated soil, sediments and groundwater resources. Technical support will include: (1) characterizing and monitoring contaminants, (2) processing permits, (3) supporting stakeholder involvement, and (4) transferring technologies.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- D/NETTS PH web site operational
- Maintain culture injection site infrastructure
- SERDP & D/NETTS program mgmt (on-going)
- O&M D/NETTS PH infrastructure (on-going)
- Conduct NEX plume monitoring
- Support technology transfer (on-going)
- Support community relation forums (on-going)
- Conduct D/NETTS PH Advisory Committee MTG
- Conduct NEX plume monitoring
- Contract award for infrastructure O&M
- Conduct NEX plume monitoring
- Maintain Air Sparging Syst #1 sensor network
- Delineation of NEX plume
- Coordinate CBC Base plume phytoremediation demo
- Monitor Purdue phytoremediation project
- Conduct NEX plume monitoring
- Coordinate D/NETTS prospective demos
- Conduct D/NETTS PH Advisory Committee MTG
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: National Test Site Location - Wurtsmith AFB

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective is to operate and maintain a National Environmental Technology Test Sites (NETTS) National Test Location at the National Center for Integrated Bioremediation Research and Development (NCIBRD) which investigates advanced technologies in site characterization, decontamination of hazardous wastes, and remediation of spill and disposal sites. Under NETTS, well - characterized test sites will be provided for technologies with evident promise for complete and cost - effective remediation with minimal environmental disruption, which are favored for facility usage. These technologies involve on-site and in-situ processes, which integrate biological and physicochemical methods for treatment of soils and groundwater contaminated with fuels, chlorinated solvents, and organic mixtures. NCIBRD is located at the recently decommissioned Wurtsmith Air Force Base (AFB) in Oscoda, Michigan, which has numerous fuel and chlorinated solvent contamination sites resulting from former Air Force activities. Activities at NCIBRD include an array of research, development, and demonstration, testing and evaluation efforts toward the transfer of field and laboratory findings into successful remediation practice. The program focuses on several specific problems relating to the development of core biotechnologies such as the enhanced understanding of microbiology and microbial geochemistry, improved means for implementing biotechnology in engineering applications, and accelerated bioremediation of contaminated soils and groundwater. Controlled programs on site characterization and in-situ integrated remediation technologies for decontamination of hazardous substances in wastes, soils, and groundwater are conducted at the facility. The majority of the sites at the base have been characterized to some extent. Several of the larger sites are under hydraulic control by way of pump-and-treat systems. A subset of three fuel and chlorinated solvent sites have been characterized geochemically and microbially in support of in-situ bioremediation. The facilities provide a focal point for coordination and cooperation within the broad community of institutions, agencies, and corporations currently attempting to develop these technologies.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Assist in preparation of peer-reviewed papers and review technology analysis reports for past demonstrations
- Review reports and distribute the results of past project activities to stakeholders
- Maintain field data quality, system readiness and safety preparedness
- Refine surveys for prospective demonstration and evaluation activities on three principal sites encompassing major organic contaminant types
- Continue to prepare base-wide overview reports on hydrogeology and updated contaminant distributions at test location
- Pursue demonstration and evaluation project contracts as well as leveraged funding opportunities
- Coordination with the USAF Base Conversion Agency, Michigan Department of Environmental Quality, and EPA to obtain approvals and permits for specific projects
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Agriculture-Based Bioremediation Program

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: This project is not focused specifically on an Army environmental requirement, but will be leveraged to the greatest extent possible. This program may affect the RABs at Army facilities. It will identify contaminated military sites and minimal local capability for environmental technology. The approach involves: partnering with U.S. Dept. of Agriculture; demonstrating agronomic restoration technologies at military or civil sites; transferring technologies to private sector; and educating community and private sector.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Award new demonstration projects through Broad Agency Announcement
- Identify markets for bioremediation technologies in the Asia-Pacific region
- Introduce biotechnology seminars for public school teachers
- Initiate environmental technology courses in college curricula

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: Environmental Toxicology Earmark

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: This project focused on two tasks:

1. Develop a scientifically-based environmental standard for type 8 jet fuel (JP-8) exposure to the general population at Air Force bases. This effort intends to characterize potential acute health effects associated with JP-8 and recommend actions to ameliorate disease/injury in exposed personnel. In addition this project worked toward assessing the environmental impact of jet fuel use, thereby understanding the parameters required to achieve a safe community environment.
2. Perform ecological risk assessment/modeling of contaminant mixtures. This risk assessment/modeling would: (1) develop/validate aquatic models for assessing effects of water-borne contaminants on aquatic fauna development and reproduction; (2) develop and validate terrestrial models for assessing effects of contaminants on terrestrial species development and reproduction; and (3) integrate data using models and Geographical Information System (GIS) to predict the effects of contaminants on both individuals and populations. This task entailed four areas: 1) Aquatic Toxicology; 2) Terrestrial Toxicology; 3) Analytical Evaluations in Support of Toxicological Evaluations; and, 4) Environmental Modeling.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Initiated performance of JP-8 risk assessment and epidemiology study
 - Held an initial epidemiology meeting to assess the risk of JP-8 to exposed populations, develop survey parameters, and to define study design
 - Formulated parameters to strengthen and support the JP-8 risk assessment
 - Determined subject eligibility, sample size, participating subject health history, exposure history, health outcome measures, control selection and site selection criteria
- Completed initial stages of ecological risk assessment/modeling for ammonium perchlorate mixtures
 - Developed research protocols unique to each species for aquatic toxicology and terrestrial toxicology
 - Submitted animal use protocols and received approved by the Texas Tech University (TTU) animal use committee
 - Initiated development and adaptation of Ribonucleic Acid (RNA) isolation techniques for mice and Xenopus
 - Initiated development of models for plant growth and plant uptake
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Due to late receipt of funding, the project has not met all performance objectives.

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COMPLIANCE:

DEMILITARIZATION

PROJECT SUMMARY

TITLE: Confined Burn Facility (CBF) Open Burning Replacement Project

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will provide an environmentally acceptable and complete open burning alternative for implementation at Navy/DoD Open Burning sites. Currently, there is not an established/proven environmentally acceptable alternative to Open Burning of a wide range of energetic waste materials. Impending federal, state, and local laws and regulations will soon make it impossible to obtain or meet RCRA permits to operate explosive hazardous waste open burning grounds, severely impacting ordnance production and demilitarization activities. The Confined Burn Facility (CBF) technology represents a practical and simple one-for-one replacement for open burning. The efficient development and demonstration of the new CBF technology is proceeding in phases. Phase four of the seven planned phases represents a live fire technology and scale effects demonstration termed the 10lb Pilot-Scale Confined Burn Facility (PCBF). All PCBF demonstration activity was scheduled for FY99. Future Phases include the 80lb Demonstration-Scale Confined Burn Facility (DCBF) design (phase five), the DCBF construction and live fire and scale effects demonstration (phase six), and the Final CBF Design Methodology for Implementation (Scaling) Report (phase seven).

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Prepare SOW for construction - PCBF
- Obtain Regulatory Authority (State of Maryland) permissions and permits - PCBF
- Award Construction Contract - PCBF
- Complete construction - PCBF
- Purchase Pan Loading System - PCBF
- Conduct PCBF Safety Review - PCBF
- Obtain Command personnel certifications -PCBF
- Conduct PCBF testing - PCBF
- Determine sizing and operational economies due to scale as compared to the 0.5lb
- Bench-Scale results and conceptual design forecasts
- Evaluate the performance of the firing chamber liner material

ANNUAL PERFORMANCE REVIEW: Met all performance objectives except for the last milestone.

PROJECT SUMMARY

TITLE: Enzymes for Degradation of Energetic Materials and Demilitarization of Explosives Stockpiles

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop a safe, economical and environmentally sound process in which biocatalysts (enzymes) can be used for degradation of energetic materials with an option of converting degradation by-products into value-added materials. The overall technical approach for the proposed research evaluated the transformation of munitions such as TNT, RDX, and HMX in different forms (compositions A, B, C, and D; H-6; Tritonal) to intermediate products using enzymes. The intermediate products, in some cases, were expected to have reduced or no toxicity and thus will be evaluated for their approval for disposal by the regulatory agencies. In other cases, the intermediates could be used as a feed stock in the chemical industry or destroyed to carbon dioxide and water using microbial and/or chemical processes. The toxicities of the intermediate products and final products were to be evaluated.

The initial focus was on the kinetics and mass transport issues involved in explosives (e.g., TNT) degradation by enzymes under heterogeneous conditions. A specific emphasis was to understand the difference between the conversion of explosives by enzyme catalysis in a heterogeneous solid-liquid system compared to a normal heterogeneous catalytic aqueous system. Different combinations of enzymes, mediators, and reaction environments were investigated.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete mass balance of TNT mineralization with Oxyrase and white rot fungi
- Report on options for generating a commercially available product from TNT degradation
- Improve mathematical model by estimating necessary critical parameters experimentally
- Identify enzymes for transformation for RDX and nitrate ester
- Identify metabolites of RDX and nitrate ester effluent
- Determine toxicity of effluent (RDX, nitrate ester)
- Conduct market evaluation of TNT conversion product
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Project cancelled in FY99 due to change of scope.

PROJECT SUMMARY

TITLE: Hypergolic Non-Detonative Neutralization in Production and Demilitarization Followed by Steam Reforming and Flameless Oxidation

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop an innovative, alternative technology to replace open burn/open detonation (OB/OD) operations for the destruction and disposal of obsolete, excess, and off-spec energetic materials. The initial focus of this project is to develop effective reagents and to understand the underlying chemistry for reacting the energetic materials with a hypergolic chemical, which neutralizes the energetic materials and precludes a detonation. The proposed approach uses organic amines, metal alkyls or amine-metal alkyl adducts to neutralize explosives. These have been shown to react hypergolically with Trinitrotoluene (TNT), Composition B, and RDX. The chemistry related to the interaction of organic amines and metal alkyls with explosives is poorly understood and one objective of this program is to further elucidate the reaction mechanisms. Two approaches are being used for the pre-treatment of explosives: (1) relatively low temperature, controlled exothermic reactions in a liquid-phase environment, and (2) solid-state, controlled hypergolic reactions. Overall these approaches have great potential in the pre-treatment of explosives to produce a non-detonable product for reuse or final treatment in a steam reforming reactor.

The project will focus on the identification of the reaction products, their toxicity and potential reuse. Thin layer chromatography, high pressure liquid chromatography, infrared, nuclear magnetic resonance, mass spectroscopy and if necessary, preparative chromatographic methods will be employed. The products will be purified to facilitate their identification, and reactions with simpler amines such as cyclohexylamine and ethylenediamine will also be conducted to eliminate the potential for polymerization which complicates product identification.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete toxicological studies with reaction products with TNT and RDX
- Complete characterization of reaction products with TNT , Explosive D and RDX
- Complete experiments with moderate quantities of energetic materials
- Initiate experiments to explore potential high value applications for reaction products
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Recovery and Reuse of HMX/RDX from Propellants and Explosives

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Currently, the U.S. Department of Defense (DoD) has no method of recovering highly valuable energetics, such as HMX and RDX, from Class 1.1 propellants and explosives. Many munitions items (including projectiles, missile and torpedo warheads, and strategic rocket motors) contain significant quantities of these energetic compounds. Current open burning and open detonation destruction practices release hazardous pollutants into the environment and negate the value of these products. This project will demonstrate new methods for extraction and reuse of HMX and RDX from warheads and other projectiles.

A pilot-scale plant (150 pounds per day) will be constructed to chemically extract and mechanically reprocess HMX from the explosive LX-14 that is used in Hellfire and Tow missile warheads. The system will also package the end-products for shipment to the user and reprocess the by-products into value-added compounds such as blasting agents. The recovery process uses common mineral acids instead of organic solvents, eliminating the need for disposal of hazardous organic wastes. Pilot-scale studies have been used to optimize the recovery process, and this demonstration will extend the recovery potential to additional explosives. The U.S. Army Armament Research and Development Engineering Center will determine if the reclaimed HMX and RDX can be qualified for new weapons systems. Samples of the reclaimed material will be independently evaluated for adherence to specifications and performance parameters. Early tests of this extraction process provided an HMX yield of 98 percent and met environmental and MIL purity standards. In the second phase of this demonstration, a subscale plant will be installed at a DoD site to process explosives removed from U.S. Navy projectiles with a high-pressure washout system. When applied at its final operational scale, this recovery process will not produce a hazardous waste stream.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Conduct sub-scale (150lb) demonstration at Ft. Wingate
- Evaluate sub-scale (150lb) plant operations
- Submit Final Report for 150lb/day Evaluation

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Supercritical Water Oxidation

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Supercritical Water Oxidation (SCWO), an environmentally friendly alternative to conventional incineration, can destroy hazardous colored smoke and dye compounds that are removed from decommissioned munitions. An innovative technology, SCWO breaks down toxic organic compounds into harmless oxidation by-products such as carbon dioxide and water, greatly reducing storage and disposal costs and environmental pollution.

The U.S. Army Armament Research, Development and Engineering Center (ARDEC), in conjunction with Sandia National Laboratories and their industrial partners, Foster Wheeler Development Corporation/GenCorp Aerojet, is demonstrating a transportable SCWO prototype for test purposes at the Pine Bluff Arsenal in Arkansas. This SCWO unit treats colored smoke and dye compositions generated during the demilitarization of conventional ordnance. SCWO is an emerging treatment technology used to destroy aqueous organic wastes in an environmentally sound manner. The process works by subjecting the waste to temperatures and pressures in the supercritical region for water (above 374°C and 3,205 psi). At these temperatures and pressures, ordinary water takes on very different properties. Most importantly, organic chemicals that are normally insoluble become completely miscible and are rapidly oxidized and destroyed.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Initiate transition of technology to production

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Molten Salt Oxidation (MSO) Technology

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: This project will provide an environmentally acceptable open burning alternative for implementation at Navy/DoD open burning sites. Molten salt oxidation (MSO) is an innovative technology that can efficiently and effectively dispose of a wide variety of materials, and can be an alternative to open burning/open detonation of energetic materials. Energetic materials are metered into a MSO treatment vessel, where organic constituents are oxidized to carbon dioxide and water. The inorganic constituents are concentrated in the molten salt bath and can be later separated for reuse, recycle, or processed for resale.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Design and have a contractor fabricate a 12-inch diameter MSO treatment system
- Decommission the 6-inch diameter MSO treatment vessel
- Install and integrate the 12-inch diameter treatment system with the existing support equipment

ANNUAL PERFORMANCE REVIEW: Decommission the 6-inch diameter MSO treatment vessel has been completed. The design of the 12-inch diameter treatment system has been completed. The contractor has not met its delivery schedule, causing the delay in the program schedule. Actions have been taken by the Government to expedite the delivery of the equipment. In addition, the program schedule has been modified to maximize performance within the remaining execution period. Delivery and installation of the MSO treatment system was rescheduled to be completed during the second quarter of FY00.

COMPLIANCE:

EMISSIONS MONITORING/DETECTION

PROJECT SUMMARY

TITLE: Advanced Passive Acoustic Leak Location and Detection Verification System for Underground Fuel Pipelines

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM: No.

DESCRIPTION: The Department of Defense (DoD) owns over 10,000 fuel storage tanks and associated piping networks that must be periodically monitored and tested for leaks. Contamination from such leaks must be remediated, often at high cost to DoD. Numerous studies have indicated that most leaks occur in pipelines, not in the tanks themselves. Currently, a number of pipeline leak detection systems meet the standards of the Environmental Protection Agency and other regulatory agencies. But while effective leak detection is in hand, there is still a need for a low-cost and rapid means of locating leaks. An acoustic system can be used as a large stethoscope to locate leaks and to remediate them quickly with minimum cost and with significant performance, operational, and cost advantages over present systems (e.g., tracer, cable, and vapor monitoring). This project demonstrates a prototype of a passive acoustic on-line or portable monitoring system, which provides real-time leak location and detection verification.

The passive, acoustic leak location system is made up of three acoustic sensors, a signal conditioning system, a wireless communication system, a data acquisition and signal processing system, and a simple user interface for initiating a test and displaying results. The sensors are attached by clamps or epoxy to the outer wall of the pipeline. Acoustic signals are measured at each sensor, passed through separate signal conditioning amplifier and filter components, and digitized by the data acquisition computer. A reference sensor and a velocity acoustic sensor, located on one side of the suspected leak, estimate the velocity of propagation of sound in the product. Position and reference sensors bracket the leak. Once the knowledge of the velocity of propagation is known, the measurements from these two sensors provide an estimate of the distance of the leak from the reference sensor. Because passive acoustic measurement for leak location can be completed quickly (e.g., tens of seconds to several minutes), the system can be used in real time and can provide immediate operational feedback not possible with existing technologies.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Establish Contracts
- Complete Hardware 80% Design Review
- Submit Draft Demonstration Plan
- Complete Software 80% Design Review
- Submit Final Demonstration Plan

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Bulk UST Leak Detection Technology

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this effort is to develop leak detection capability for 20 large bulk tanks, 12 million gallon capacity each, at Fleet and Industrial Supply Center (FISC) Red Hill facility. Pearl Harbor is the Department of Defense's (DoD's) largest fuel terminal with a storage capacity of approximately 320 million gallons of fuel. Approximately 80% of this capacity is stored in 20 underground tanks in a mountain ridge called Red Hill (five miles from Pearl Harbor) on the island of Oahu. These tanks reside over one of the main Oahu aquifers and therefore early detection of any fuel leakage is of paramount concern. With existing fuel inventory systems, fuel leakage of many thousands of gallons (over 50,000 gal) would presently go undetected. The Red Hill tanks measure 100ft in diameter and 250ft in depth making these tanks the largest vertical dimension tanks in the world. Special leak detection system configurations and instrumentation must be developed to obtain sufficient accuracy for these high capacity tanks.

A Low Range Differential Pressure (LRDP) system was developed and tested on a 600,000-gallon tank at NAS North Island. The system was 3rd party tested under EPA approved guidelines and was certified for a leak rate of .38 gallons/hr, the best in industry to date for bulk fuel tanks. Since the LRDP precision is related very closely to tank diameter, the pending Red Hill tank (100ft diameter) certification test results are expected to be very comparable to the results achieved with the North Island tank (88ft diameter). The LRDP has been packaged as a commercial system, fully automated, and integrated with the DoD Fuel Automated System (FAS) hardware and software protocols.

This technology is cooperatively funded by the Navy and ESTCP (see p. B-24).

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Conduct LRDP Test and Evaluation
- Prepare Transfer/Procurement Package
- Testing must meet EPA approved protocol "Alternative Test Procedures for Evaluating Leak Detection Methods: Evaluation of Bulk Field Constructed Tanks"

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Characterization of Particulate Emission: Size Characterization and Chemical Speciation

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The current National Ambient Air Quality Standards (NAAQS) for particulate matter (PM) is under review and will probably result in additional and more stringent future standards below 2.5 microns. The Department of Defense (DoD) needs to characterize both the particle size and the chemical composition of PM from several emissions sources, such as turbines, boilers and vehicles, which would likely be impacted. Characterization of the health risks of constituents at various size ranges would allow the most effective design of pollution control devices.

This project will develop innovative sampling and analytical techniques utilizing the following instruments: (1) Portable dilution sampler for use with aerosol instruments; (2) Aerosol Time-of-Flight Mass Spectrometer (ATOFMS) for positive and negative ion detection; (3) Photoelectric Aerosol Detector (PAS) for rapid, composite measurement of polyaromatic hydrocarbons (PAHs), which are prevalent components of PM; (4) Micro-orifice impactors to obtain size-segregated particles for chemical analysis; and (5) Standard chemical analyses of filter samples targeted toward likely toxic constituents. After calibration of the instruments on major classes of DoD-relevant sources, a detailed field study will be conducted at Hill Air Force Base (HAFB), which can provide a wide representation of typical DoD emissions sources. There will be particular emphasis on trying to close material balances when using number-based particle counting equipment. The techniques investigated will also be evaluated in terms of performance, cost, relative ease of use, and time required for meaningful sampling and interpretation of data. Recommended protocols, methodologies, and training of staff in equipment calibration and use will be provided to Air Force personnel. Both the ATOFMS and PED are available commercially.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Development of test plans for HAFB & NFESC
- Testing and analysis of results of PAS & carbon analyzer tests at Hill AFB
- Planned experimental sampling campaign at HAFB
- Enhancing capability of PAS and testing at Hill AFB
- Enhance capability & calibrate ATOFMS at NEFSC
- Development of element carbon analyzer
- Accelerate use of PAS on HAFB for ambient measurement
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Continuous Emissions Monitor for Hazardous Air Pollutant Metals

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM: No.

DESCRIPTION: Conventional methods of measuring airborne hazardous metals in stack gas effluent at Department of Defense (DoD) facilities typically involve manual sampling techniques that are not responsive enough to facilitate pollution control. This has encouraged the development of continuous emissions monitors (CEMs) that are capable of providing analytical information in or near real-time. The purpose of this project is to perform validation testing and demonstrate sustained performance of a prototype CEM.

Validation testing of a CEM is being performed in a controlled environment at a full-scale permitted incineration test site. Sustained performance evaluation will then be conducted on a rotary kiln deactivation furnace at an Army demilitarization facility and on the plasma arc waste treatment unit to be installed at Norfolk Naval Base. The prototype system that will be tested was developed under the Army's Demilitarization Technology Research and Development Program for Conventional Ammunition. The system employs automatic, isokinetic stack gas sampling and injection of the sample into an inductively coupled argon plasma spectrometer, which detects and measures the atomic emissions of the excited hazardous metals in the sample. The system has detection capability of less than one part per billion for all 14 air pollutant metals designated as hazardous by the U.S. Environmental Protection Agency.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Install CEM production unit at Army demilitarization facility for supplemental validation testing at test site
- Select site for demonstration
- Select Army furnace site for supplemental validation testing
- Initiate supplemental validation testing
- Complete supplemental validation testing
- Complete demonstration on 1236 furnace

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Detect and Identify Multiple Hazardous Air Pollutants (HAPs) at Extended Distances

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop a new class of sources for active remote sensing of hazardous air pollutants (HAPs) using ultra broadband (UB) radiation, and techniques for their detection and identification. UB radiation can provide the necessary illumination required for active remote sensing to allow real-time ranging and identification of HAPs at extended distances. The mechanism for the generation of UB radiation is based on self-phase modulation of picosecond laser pulses in a nonlinear optical medium. Continuous UB radiation can be generated with extremely high efficiency and high average power by beating two laser beams with slightly different frequencies. The bandwidth of the radiation can extend from the optical to the Infrared (IR) regime. The source size of the UB radiation is extremely small, which allows for beaming the radiation over extended distances of several kilometers.

The generation of UB radiation in various nonlinear materials is being evaluated using existing laser facilities at the Naval Research Laboratory (NRL). Lasers with optical and near-IR wavelengths are being used to generate UB. The conversion efficiency and bandwidth will be optimized by selecting the appropriate nonlinear medium. The quality of the UB radiation beam is being measured and its propagation in air characterized. The methodology and diagnostics necessary to evaluate the UB spectrum are based on hyperspectral imaging techniques that are being developed at NRL. Proof-of-principle experiments on active remote sensing are being performed, and data reduction techniques for analyzing complex spectral signatures is being studied.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop data analysis program and initiate proof-of-principle experiment for active remote sensing using UB radiation
- Complete study of propagation characteristics of UB radiation in air
- Complete data collection of proof-of-principle experiment for active remote sensing using UB radiation
- Initiate study of propagation characteristics of UB radiation in air
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Field Validation of Real Time Airborne Lead Analyzer

BUDGET ACTIVIT: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM: No.

DESCRIPTION: Many Department of Defense (DoD) facilities, including indoor and outdoor firing ranges and lead paint abatement sites, need to obtain rapid, on-site measurements of airborne lead levels that meet or exceed the Occupational Safety and Health Administration (OSHA) exposure limits. Environmental responses at lead-based paint facilities and firing ranges require Environmental Protection Agency - mandated monitoring as well as verification of worker safety according to OSHA regulations. These regulations are costly to implement and do not provide a real-time method to verify compliance. As a result, the need for a rapid, portable, low-cost analyzer for quantifying respirable lead and surface dust has been communicated extensively throughout DoD and private industry.

This project will demonstrate the AeroLead Analyzer, a real-time airborne lead analysis tool. The AeroLead portable lead analyzer automatically samples and measures metal concentrations in ambient air. Air samples are drawn through a new sample filter/detector assembly, and the airborne lead is then concentrated into a specially designed aqueous phase and analyzed volumetrically. An integrated airflow meter is used to determine air-sample volume, which is combined with the volumetric data to yield accurate airborne lead concentration. The instrument then automatically resets for the next sample. The analyzer has the capability to automatically measure airborne lead concentrations to below 10 ug/m3, within a total sampling and analysis time of 15 minutes.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Design Review
- Prepare Demonstration Plan
- Fabricate AeroLead Instruments
- Start Standard Reference Materials (SRMs) Testing (lab)

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Laser-Based Spectrometers for Air Emissions Monitoring

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The original objective of this project is to develop a combined laser-based system for monitoring Volatile Organic Compounds (VOCs), Nitrogen Oxides (NO_x), and metals for compliance with the Clean Air Act Amendments of 1990. For gaseous pollutants, an infrared (IR) spectrometer based on the new, periodically-poled lithium niobate (PPLN) laser technology is being used. For metals emissions monitoring, laser induced breakdown spectroscopy (LIBS) is being employed. Due to differences in development schedules, these will be separate efforts.

The focus of the IR spectrometer project will be development of the breadboard IR spectrometer and development of the OPO tuning mechanism. The air-spaced etalon will be installed in the cavity and coupled with the frequency lock-loop. This should allow the target high-resolution tuning range of 30 GHz to be approached. Miniaturization will involve replacing the current rack-mounted hardware for locking and signal analysis with single-board or very compact units. Frequency measurement will be accomplished using reference gas cells in conjunction with reference etalons. A more compact photoacoustic cell will be installed.

The Portable Laser Induced Plasma Spectroscopic System (PLIPS) will focus on completion of the aerosol-beam focusing module and gateable micro-spectrometer. The module employs a single-stage transonic flow schematic to bring particles that carry metals to the focal point of the laser beam. The aerosol device will be an insertion module to the current LIPS system. An air-cavity multi-pass optical spectrograph is being designed and manufactured. This spectrometer will provide a needed time-resolved capability for multi-elemental analysis that PLIPS was capable of performing.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop aerosol-beam focusing module
- Complete assembly of PPLN spectrometer
- Develop software algorithms
- Evaluate spectrometer performance (VOC selectivity and sensitivity)
- Field testing of PPLN spectrometer
- Bench evaluation of picosecond laser
- Test focusing module (LIPS)
- Test digital control and signal processing software (LIPS)
- Develop gateable micro-spectrometer (LIPS)
- Evaluate system performance on simultaneous detection of multiple elements through lab and field tests
- Optimization of spectrometer and software
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Particulate Matter Physical Chemical Characterization and Monitoring System

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0605502F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will produce a prototype instrument that will enable DoD to better characterize and quantify its emissions of fine particulate matter (PM_{2.5}). The design must render this prototype instrument capable of high precision segmentation of fine particles by aerodynamic diameter and broad spectrum chemical analysis of those particles. Follow-on efforts may include the evaluation of the non-polluting benefits of various fuel additives. The EPA's planned regulation of this new size category of PM could have a significant impact on DoD operations and costs. A full understanding of DoD PM_{2.5} emissions should help with development of control strategies and in working with regulators to avoid excessive constraints.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- 65% completion of the final design for a particle physical characterization subsystem
- 70% completion of final design of the mass spectrometer-based chemical characterization system
- 40% completion of construction of particle physical characterization subsystem
- 10% completion of the mass spectrometer-based chemical characterization system

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Portable Environmental VOC Monitor

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0605502F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will develop a rugged, low-cost, hand held instrument for measuring volatile organic compounds. The instrument will be based on surface acoustic wave technology from Sandia National Laboratory integrated with the PCMCIA protocol to make the sensor a plug in capability for standard hand held computers.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Device fabrication
- Laboratory testing
- Field demonstration

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Real-Time Fuel Leak Detector**BUDGET ACTIVITY:** 2**PROGRAM ELEMENT:** 0605502F**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: This project aims to develop an instrument capable of detecting fuel leaks with a quicker response time and greater sensitivity than current available technology.

Enormous quantities of bulk fuels are consumed for military and commercial transportation needs every day. AF personnel, dealing in amounts of this magnitude, have a major responsibility to ensure proper logistics management, to maintain fuel systems and tanks on aircraft, to minimize fuel-related impact on the environment, and to protect the occupational safety of workers. Development of a user-friendly, instrument that specifically responds to fuel hydrocarbons in the sub-ppmv range in milliseconds will allow the AF to shift from a reactive to a proactive mode. Existing approaches are inadequate due to low sensitivity, susceptibility to interference, slow response, and complicated operational and/or maintenance requirements.

Resonance enhanced multi-photon ionization (REMPI) spectroscopy will be tested around tank airspace (or item of interest) for presence of specific hydrocarbon constituents, found in common fuels. Due to the method's extremely high sensitivity, it can easily pinpoint leaks of such small nature that only vapor is escaping, thus tracer additives aren't necessary. Applications for fuel vapor leak detector may include use as a surveillance (i.e., under-ground storage tanks) and/or monitoring (i.e., indoor air quality) tool.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Reduce overall size of current laser
- Increase sensitivity of readings: Below 100ppbv for JP-8; below 30 ppbv for unleaded gasoline
- Demonstrate superiority of existing technology

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Resonance Enhanced Multi-Photon Ionization (REMPI) and Photoemissive Ion Mobility Spectroscopy (IMS) Development

BUDGET ACTIVITY: 6

PROGRAM ELEMENT: 0620202F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will advance REMPI IMS technology to the level of a practical methodology for use outside the laboratory. In addition to fabricating a prototype device, the library of temporal waveforms will be expanded to provide recognition of a greater number of gases alone and in mixtures.

ANNUAL PERFORMANCE OBJECTIVES FOR FY 99:

- Add chemicals from the EPA priority list to the spectral database
- Construct the laboratory apparatus
- Model ion diffusion

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Surfactant Sensor for AFFF Detection and Diversion

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to demonstrate and validate the performance of a novel device for monitoring surfactants or the foaming potential of a solution so that disastrous surfactant incidents at POTWs can be automatically prevented. An innovative method for real time, continuous monitoring of aqueous film forming foam (AFFF) in Navy process streams, such as the influent to Navy wastewater pretreatment facilities is required. AFFF is commonly found in bilge water and wastewater from Navy fire-fighting training operations. The significant problems created by AFFF in Navy wastewater pretreatment facilities that discharge to publicly or privately owned domestic wastewater treatment works are: 1) interference with level sensing devices, 2) solids carry over, and 3) interference with the biomass. These problems can lead to failure to meet Federal and State pretreatment requirements. As an example, AFFF in oily wastewater from Navy ships caused a process upset of an oily waste water treatment plant operated on the Atlantic coast. Foamy water and floating solids containing heavy metals were discharged to the local river, resulting in a Notice of Violation. The compliance problem is exacerbated by the fact that AFFF is not continually present in the wastewater to be treated. AFFF can enter and pass through a treatment plant, causing upsets, without being detected by present sampling methods. Thus a real time, on-line sensor is needed that could detect the presence of AFFF and divert wastewater for special handling or treatment.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Develop test plan
- Identify AFFF analytical detection method
- Collect Mayport AFFF wastestream samples
- Design/Fabricate prototype sensor
- Conduct bench scale tests
- Optimize sensor design variables
- Provide on-line monitoring to detect AFFF at concentrations at low concentrations (<50ppm)

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Validation of the Low Range Differential Pressure (LRDP) Leak Detection System for Small Leaks in Bulk Fuel Tanks

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Department of Defense (DoD) owns over 1,000 underground storage tanks (USTs) of varying capacities. Current federal regulations have deferred bulk USTs from the regular annual tightness test or a monthly monitoring test other USTs must undergo. Regulatory changes have eliminated annual tightness tests and will require bulk USTs to undergo monthly monitoring. This presents a unique problem for DoD because DoD is the only owner of bulk USTs. No system in existence is capable of testing both the walls and bottoms of bulk USTs for leaks. This project demonstrates the Low Range Differential Pressure (LRDP) leak detection system for bulk fuel USTs. The LRDP is capable of detecting up to a 0.5 gallons per hour (gph) leak on a monthly basis and a 0.2 gph leak annually.

LRDP is a differential pressure (mass based) measurement system capable of detecting very small leaks in bulk fuel USTs. This system relies upon a closed reference tube that is the same height as the tank and is filled with fuel to the same level as the fuel in the tank. The reference tube configuration enhances the precision of the differential pressure sensor measurements by significantly reducing the dynamic range required of the sensor. Next, the difference in level between the fuel in the tube and that in the tank is accommodated. This allows the use of a dependable and robust off-the-shelf differential pressure transducer, while maintaining the precision required to meet bulk tank leak detection regulatory standards.

This technology is cooperatively funded by ESTCP and the Navy (see p. B-13).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Prepare Technology Demonstration Plan
- Design, assemble, integrate & checkout alpha prototype
- Conduct system DEM/VAL & certification testing at selected DoD installations

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

COMPLIANCE:

ENVIRONMENTAL IMPACTS OF MILITARY EMISSIONS

PROJECT SUMMARY

TITLE: Additional Capabilities for the Fuel Jettisoning Simulation Model (FJSIM)

BUDGET ACTIVITY: 6

PROGRAM ELEMENT: 0603723F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Fuel Jettisoning Simulation (FJSIM) software is a tool that helps assess the environmental and health impact of fuel dumping events by estimating the amount of fuel that will reach the ground from a given aerial fuel dumping incident. It is required because the conversion from JP-4 to less volatile JP-8 substantially increased the likelihood of noticeable JP-8 groundfall from standard fuel jettisons. This project addresses the needs expressed by AF Special Operations Command and Air Education & Training Command to predict groundfall from rotary wing aircraft (namely the CV-22, H-60 and H-53) by incorporating the necessary dispersion algorithms and aircraft data.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Incorporate rotary wing aircraft capability
- Expand aircraft data inventory to include CV-22, H-60, H-53
- Enhance data output with calculations of total surface area affected, total mass and volume at the surface, and the change in maximum deposition over time

ANNUAL PERFORMANCE REVIEW: All performance objectives met.

PROJECT SUMMARY

TITLE: Alternative Approach to Copper Discharge Regulations

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Copper is a high profile pollutant for the Navy. The EPA has established very low water quality criteria for total copper, and many states have similarly low criteria. However, research over the past decade has shown that toxicity is not closely related to the total copper concentration because copper may be bound to organic and inorganic materials in the water, which makes it less available, and therefore less toxic to marine organisms. This task will develop the information necessary to permit a more rational and scientifically valid approach to regulate Navy copper discharges.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete copper measurement program (CMP) of San Diego Bay
- Select additional CMP site
- Optimize protocols and initiate CMP at other site
- Conduct EPA standardized toxicity testing

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Harbor Processes**BUDGET ACTIVITY:** 1**PROGRAM ELEMENT:** 0601153N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: Basic research is being performed to determine the identity, fate and impact of pollutants in the harbor environment. Research is also being performed to develop remediation methods that may be used to reduce the levels of harmful pollutants. This knowledge base will be important in determining the Navy's role in the environmental protection of harbor environments. Areas of study include:

- Determining the effects of metal and diesel-fuel contaminants (PAHs) on estuarine food webs, and how they interact to influence the microbial, invertebrate, and juvenile fish components of the estuarine community.
- Studying mechanisms of microbial degradation of pollutants (PAHs, hydrocarbons, PCBs) in marine/estuarine sediments.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Publication in peer reviewed literature to establish Navy proactive leadership and discovery in the S&T area

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Plume Chemistry Modeling for RISO Analysis

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602202F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The purpose of this project is to help determine the impact of rocket motor emissions on stratospheric ozone. Detailed chemistry models will be used in conjunction with actual measurements to determine how rocket emissions chemically interact with chemicals in the stratosphere and how those interactions may affect stratospheric ozone.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Run and analyze multiple computer simulations on data gathered by the RISO project
- Present results in final report format at technical conference and publish

Annual Performance Review: Met all performance objectives. Presentation of results delayed until May 00 due to conflicts in scheduling.

PROJECT SUMMARY

TITLE: Space Launch Toxic Risk Assessment Model Validation

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602202F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project helps address a high priority AF Environmental Safety and Occupational Health (ESOH) need. Its overall objective is to improve the accuracy, validity, and legal defensibility of the space launch toxic risk assessment models used at the Eastern and Western Ranges. Such improvements may improve launch availability, will improve protection of public health and the environment and will reduce Air Force liability.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Invite and select toxicological experts to participate in expert elicitation
- Develop appropriate questionnaire and test on small sample of experts
- Distribute questionnaire and analyze results
- Distribute second iteration and analyze results
- Incorporate the results into the Launch Area Toxic Risk Assessment (LATRA) model

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Integrated Bioenvironmental Hazards Research Program

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: This program was a continuation of a DTRA-funded Bioenvironmental Hazards Research Program. The overall objectives of the program are to develop a suite of interrelated research modules that address DoD environmental issues in a holistic fashion, with particular emphasis on the Navy's interests in environmental impacts on riverine, estuarine and coastal ecosystems. These research modules are entitled: 1) Environmental Signals and Sensors, 2) Ecosystem Science, 3) Environmental Management and Remediation, and 4) Communication and Education. Within these modules, specific research themes targeting persistent chemicals in the environment included: the development of model systems for human or wildlife health; mathematical modeling for toxicity risk assessment; development of biosensors and biomarkers for environmental toxicants; aquatic and atmospheric fate/transport in the Mississippi River basin; biodegradation, remediation and prevention of military activity-related pollution; HBCU student education; development of communication mechanisms for information dissemination to ONR, DoD and public; and environmental informatics.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Conduct an internal solicitation for proposals to fulfill the research themes listed above
- External peer-review selection process to identify specific projects to be funded

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

COMPLIANCE:

**HAZARDOUS AIR POLLUTANTS (HAP)/VOC AND
PARTICULATE EMISSIONS CONTROL**

PROJECT SUMMARY

TITLE: Additional Capabilities for the Emission Reduction Planning Model (ERPM)

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The purpose of this project was to determine the feasibility of establishing an interface between the Air Compliance Advisor (ACA) software and the Air Permit Information System, and other such software. Such an interface could increase the use, applicability and willingness to use the ACA, developed by AFRL.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Conduct model interface analysis of target systems
- Develop prototype model interface for ACA and generic air emission inventory programs

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Air Pollution Modeling (APM)**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: This effort will evaluate approaches for addressing air pollutant transport, dispersion and transformation questions involving Navy installations and operations. The objective is to demonstrate use of computer air quality simulations to evaluate effects of operational activities and compliance strategies on air pollution. The search for additional emissions reductions to satisfy requirements of existing and new State Implementation Plans (SIPs), and national air quality standards is resulting in increased pressure on Navy/DoD installations and activities. Emissions from mobile sources such as ships, aircraft, and motor vehicles are considered potential sources for making significant reductions. Unfortunately, strategies proposed by EPA and other agencies might be based on erroneous assumptions and conclusions, yet have the potential to be devastating to Navy operations. The goal of this project is to provide the Navy with the ability to protect its interests by making independent evaluations of air quality compliance strategies.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Review air transport and aerosol dispersion models
- Demonstrate computer model simulations of the downwind impact of pollutant transport
- Prepare interim report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Automated Paint Application, Containment, and Treatment System

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop and demonstrate an automated paint application, containment, and treatment system for application to ship overhaul and repair operations in a dry-dock environment. Current practices during painting operations conducted in Navy and commercial dry docks generate atmospheric and aqueous contaminants. Atmospheric contaminants result from the evaporation of volatile organic compounds (VOC) such as toluene, xylene, and methyl ethyl ketone, which serve as paint solvents. These compounds are regulated by the EPA. Aqueous contaminants, such as copper and zinc, are paint constituents that protect the ship hull. They are deposited in the dry dock from paint overspray caused by manual paint spray operations, and released to the environment during dry dock flooding and pumping cycles. To comply with the Clean Air and Clean Water Acts, the Navy and the ship repair industry must contain and control air emissions and overspray associated with the ship coating application processes. The system is being cooperatively developed and demonstrated by Navy 6.2 and 6.4 programs to accelerate implementation.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Demonstrate prototype overspray collection device
- Complete conceptual design of overspray treatment system
- Initiate prime contractor activities for systems integration with developed technologies
- Demonstrate 90-95% overspray capture efficiency

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Control of Cutting and Arc-Gouging Emissions

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this effort is to characterize air emissions associated with cutting and arc-gouging operations at Navy industrial activities and to investigate and demonstrate emission control technology. In order to comply with increasingly stringent EPA and OSHA requirements, the Navy and other ship repair facilities must contain and/or control air emissions associated with cutting and arc-gouging operations.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Measure emissions at PSNS
- Conduct survey of cutting technology
- Conduct demonstration of selected technology (Argon-Hydrogen Plasma Arc)
- Demonstration of reduced emissions for Argon-Hydrogen Plasma Arc cutting

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Development of a Catalyzed Ceramic Filter for Combined PM_{2.5} Removal and VOC and CO Oxidation

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The project's objective is to develop high performance filters applicable to the treatment of a number of Department of Defense (DoD) combustion gas streams. The filters will be highly compact, ceramic-membrane-coated, silicon carbide (SiC) monolith filters, which can be additionally coated with non-selective catalysts to achieve simultaneous removal of particulate matter while oxidizing vapor-phase volatile organic compounds (VOCs) and carbon monoxide (CO). The oxidation catalysts can also result in "passive" regeneration of soot to allow extended continuous operation.

The project will be carried out in three phases to develop high performance filters to control pollutant emissions from combustion gas sources: (1) Development and characterization of SiC monolith filters which will be operated in various modes, either for high-efficiency full-particulate-retention, passive catalytic regeneration or backpulse regeneration; (2) Scale-up of filter construction, catalyst impregnation methods, and testing; and (3) Single-filter, slip-stream tests at selected DoD user sites.

Three types of filter will be tested. The first is a backpulse-regenerable, compact, ceramic filter capable of reducing particulate concentrations to PM_{2.5} compliant levels. The second is similar to the first except that an oxidation catalyst will be deposited on and within the pore structure in order to simultaneously remove gaseous pollutants such as VOCs and CO. The third filter type will be similar to the first except that an oxidation catalyst for removal of organic particulate will be deposited on the surface of the membrane coating. This catalyst will passively regenerate the filter by oxidizing the filtered particulates, thereby eliminating the need for backpulsing. After the development of prototype filters, field tests will be conducted to demonstrate the efficacy of removing particulates, VOCs and CO from selected gas streams.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop a variety of small test filters
- Start Filter Coupon Testing at University of North Dakota Energy and Environment Research Center (UNDEERC)
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Development of Non-Thermal Plasma Reactor Technology for Control of Atmospheric Emissions

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The overall objective of this project was to evaluate and develop new non-thermal plasma (NTP) reactor technologies for Department of Defense (DoD) air emissions control applications while providing a basis for selecting the most appropriate non-thermal plasma (NTP) technology. This was accomplished by evaluating the performance of prototype and pilot-scale NTP reactors (i.e., corona, dielectric barrier, and electron beam) for Nitrogen Oxide (NO_x) and Hazardous Air Pollutant (HAP) abatement and specialized Volatile Organic Compound (VOC) control. The development of an efficient, reductive-model NO_x processor was a key goal.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete reactor module scale-up & optimization tests
- Document initial design of field-pilot equipment and install system at field-test location
- Determine operating conditions for optimal destruction using dielectric-barrier reactor
- Complete field-pilot tests and data analysis
- Complete letter report on preliminary field-test results
- Document selection basis & technology recommendations
- Procure & shakedown field-pilot equipment
- Complete field-pilot system design & design reviews
- Complete field-demonstration test plan document
- Determine concentration profiles of important intermediate species in reactor (direct support of model refinement)
- Compare CFD model runs with ARL-measured data for OH-radicals; finish design-optimization studies for gas flow & discharge properties
- Test CFD model with a large number of discharge sites & couple to latest chemical kinetics mechanisms
- Complete cost-effectiveness/economic assessment report for designed field-pilot equipment
- Complete optical & GC/MS species measurements of simulated jet-engine exhaust & compare with CFD calculations
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Dust Control on Roads, Trails, and Landing Strips

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Army training activities have the potential to produce substantial quantities of airborne dust from land based mobilization of personnel and equipment. Airborne dust is generated during movement of tracked and wheeled vehicles, and from prop-wash associated with rotary-winged aircraft operations. Dust emissions are regulated by the Clean Air Act. In many instances, existing technology and equipment fail to meet these requirements. PM-2.5 standards require an even lower level of dust emissions than PM-10, which could affect the Army training mission. Current dust suppression techniques utilized by the Army include water application. Dust suppression techniques must be identified and/or developed to allow FORSCOM, TRADOC, and ARNG installations to conduct training activities with wheeled/tracked vehicles and rotary-winged aircraft.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop guidance on particulate matter 2.5 characterization methods and models and suppression technologies that will lead to improved chemical technologies for dust control

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: Membrane-Mediated Extraction and Biotreatment of VOCs

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Until alternative coating materials and repainting operations become available, treatment of fugitive volatile organic compound (VOC) contaminant releases during application or removal of DoD aircraft coatings is necessary to maintain compliance with the Clean Air Act Amendments of 1990. Currently available VOC emissions control technologies are costly at the high volumetric flow rates and low contaminant concentrations associated with ventilation of paint spray booths.

In conjunction with the partitioned recirculation flow reduction technique, this project will develop a novel Membrane BioTreatment (MBT) system, which combined a first-stage microporous, polypropylene, hollow-fiber membranes unit to extract and concentrate VOC contaminants into a low-volatility organic stripping fluid, with a similar second-stage membrane unit in which the VOCs are extracted into a nutrient medium for biotreatment. VOC contaminants are completely metabolized by the microorganisms. Independent operation and optimization of each stage of the process will accommodate intermittent painting operations and reduce equipment size.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Install & Evaluate Integrated Pilot MBT System in Lab
- Select coated module
- Evaluate bench-scale mass transfer rates at EPA
- Evaluate biotreatment module performance using VOC mixtures
- Evaluate mass transfer rates of VOC mixtures at NCSU
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: This project has been delayed due to procurement problems in obtaining the gas exchange module membranes. The membranes are to be delivered 4/00 for analysis by NCSU.

PROJECT SUMMARY

TITLE: Optimization of an Innovative Biofiltration System as a VOC Control Technology for Aircraft Painting Facilities

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Until alternative coating materials and depainting operations become available, treatment of fugitive Volatile Organic Compound (VOC) contaminant releases during application or removal of coatings is necessary to maintain compliance with the Clean Air Act Amendments of 1990. Currently available VOC emission control technologies are costly at the high volumetric flow rates and low contaminant concentrations associated with the ventilation of aircraft hangars.

This project will develop an innovative, high flow-rate biofiltration method for treating VOC-laden air emissions. Biofiltration of painting off-gas streams currently is limited, not because of insurmountable technical problems but simply because current systems have not been designed to handle the operating conditions typical at these facilities. Innovative design features and biofilter configurations are being investigated, tested, and applied to an actual Air Force paint spray booth.

The following innovative design features are being investigated for their ability to improve biofilter performance for paint spray booth applications: (1) a recirculating inoculation method to shorten the bioreactor start-up period; (2) directionally-switching operation to improve biomass distribution and prevent clogging; (3) slip-stream feed to maintain high biomass activities during paint spray booth shutdown periods; and (4) an aerosol nutrient delivery system to efficiently deliver nutrients and moisture to the biofilm. Since bioreactor performance is strongly influenced by the contaminants being treated, the effectiveness of each design modification will be determined under single (e.g., ethyl acetate) as well as multiple [e.g. methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), toluene] contaminant conditions representative of paint spray emissions. Other risks are whether stable and effective, long-term operation can be achieved while operating in a directionally-switching mode and using an aerosol nutrient/moisture delivery system.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Evaluate Pall Ring Packing Material
- Investigate Paint VOC Mixture Degradation Patterns & Inhibition
- Evaluate Foam Packing Material
- Optimize slip feed configuration, Single VOC, Continuous operation
- Optimize switching frequency, Multiple paint VOC
- Optimize slip feed configuration, Multiple VOC, Continuous operation
- Optimize switching frequency, Single paint VOC
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Plasma Assisted Catalytic Control of NO_x

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to further develop and optimize selective catalytic reduction (SCR) technology by using a non-thermal plasma (NTP) to assist with the catalytic destruction of nitrogen-species contained in gaseous emissions. It will extend bench-level observations of the cold-plasma-induced catalyzed chemistry of propene in simulated combustion-exhaust gases to include mixtures of fuel constituents common to JP-8 in actual combustion exhaust.

In the SCR process, the destruction of partially oxidized nitrogen-based contaminants found in combustion-exhaust emissions proceeds by oxidation of nitrogen-species to NO₂ which are subsequently reduced to N₂ by a hydrocarbon. By choosing oxidation-catalyst components that pre-convert NO fully to NO₂, mechanically mixed with reduction-catalysts, catalysts previously regarded as inactive for NO_x reduction have been shown to become efficient. Bench-scale studies on a simulated exhaust gas using propene as the reductant have accomplished a very efficient conversion of the mixture to N₂, CO₂, and water. The main technical challenge is maintaining high efficiency for NO_x reduction when flow-rates are increased to pilot-scale (50 cfm), and when diesel fuel (and kerosene-like liquid hydrocarbons) is used as the reductant. The project is assembling and evaluating a pilot-scale NO_x- and particulate- control device implementing the refined plasma-assisted SCR concept to treat exhaust flow from a Cummins diesel engine generator. Data from this pilot-scale test will support estimates of the cost and performance of operating this technology as a full-scale emission control process and determine the extent of control that can be realized.

The focus is to characterize and optimize the atomization and mixing of the liquid hydrocarbon reductant. Other options for optimizing the injection of the liquid hydrocarbon into the de-NO_x reactor are being investigated. A gas chromatograph system will be installed and used, together with a flame ionization detector and a Fourier Transform Infrared Spectrometer, to analyze the mixing and speciation of the fuel during the injection process. The NO_x reduction efficiency will be characterized as a function of the engine power consumption, fuel consumption, and exhaust flow rate through the de-NO_x reactor.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Pilot-scale testing - characterize DRE as a function of power consumption, fuel consumption and engine exhaust flow rate
- Construction of pilot-scale (≤ 50 cfm) system
- Engineering cost estimate for full-scale system
- Economic and environmental analyses of greenhouse gas elimination
- Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Reduction of Diesel Engine Particulate Emissions Using a Catalyzed, Self-Regenerating Ceramic Filter

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Diesel engines are widely used throughout the Department of Defense (DoD) for powering tactical and non-tactical vehicles and vessels, off-road equipment, engine-generator sets, aircraft ground-support equipment and a variety of other applications. Although diesel engines, like gasoline engines, are known to emit several types of pollutants into the atmosphere, human health concerns regarding the penetration of the small particulate matter (PM) [specifically those having diameters of less than 2.5 microns designated PM_{2.5}] into the deeper regions of the lungs have greatly increased interest in diesel PM emissions in the recent past. This increased concern about PM health and safety effects and DoD's policy of abiding by all air pollution regulations and identifying and helping to advance those technologies that show promise for improvements in the workplace and the environment have led to ESTCP support of this project.

For more than a decade, investigators have developed the use of soot filters to reduce PM emissions from diesel engines. However, important unresolved technical and economic problems have plagued these filters and prevented their widespread application. An approach for resolving the most important of these problems, regeneration of the soot filter on-line during engine operation, has now been developed by Cummins Engine Company and its catalyzed soot filters (CSF) co-developers, Engelhard Corporation of Eagan MN and Nelson Industries of Stoughton WS. This project will demonstrate self-regenerating CSFs for reducing these particulate emissions from diesel engines.

Initial field tests of the CSF have been completed on eight urban buses operated by the New Jersey Transit Authority. Results demonstrated CSF life-times of greater than one year (>100,000 miles) and PM emission reductions of greater than 80 percent. No other technology is available with a similar capability. The Naval Facilities Engineering Service Center (NFESC) will work with the CSF developers to show that equivalent CSF durability and PM emissions reductions can be obtained for a range of DoD diesel engine systems.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Continue preparation of preliminary list of CSF test platforms
- Prepare/Initiate CSF calibration tests at Cummins Engine Company
- Initiate evaluation of engine systems for field screening tests

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Reduction of Particulate Emissions from Jet Engine Test Cells Using an Annular After-Reactor

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will develop a prototype Annular After Reactor (AAR) jet-engine attachment to reduce particle emissions from jet engine test cells (JETCs). The AAR, positioned in the flow path of the jet engine exhaust tube, is simply a hollow pipe which delays mixing of exhaust gases with the surrounding air stream for a sufficiently long residence time to permit incineration of the particulate matter (PM), up to 90%, with minimum pressure drop. With a slight modification, the system may also be adapted for removal of NO_x, CO and unburned hydrocarbons.

The project will be carried out in four phases: (1) analytical and computer studies to refine the basic AAR fluid dynamics model and establish design criteria for field tests; (2) intermediate-scale field testing to complete the AAR design; (3) full-scale AAR system fabrication and field testing at a California Naval Air Station; and (4) data reduction and analysis to provide the recommended AAR system for PM reduction. The most challenging technical aspect of this study will be the efficient and rapid mixing, and combustion, of the injected natural gas within the AAR to achieve a proper temperature profile. Excessive pressure drops are expected to be eliminated by using a jet exhaust diffuser on the inlet to the AAR. The challenges of non-steady operating conditions will be addressed by using a feed-forward control system to make required AAR adjustments in concert with programmed changes in engine operating conditions. By maintaining the temperature of the exhaust gases within the AAR at 2000F, it is believed the generation of nitrogen oxides within the AAR will be insignificant.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete sub-scale testing
- Complete JET/AAR Computer Modeling
- Select intermediate scale test site(s)
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Rocket Motor Exhaust Scrubber for Static Firing Operations

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this effort is to develop and demonstrate an environmentally complaint way to treat the off-gases generated from rocket motor test firings without affecting the collection of the performance data. While ensuring that the technology is scaleable. No known systems exist for the scrubbing of rocket motor exhaust without affecting performance data collected during the test. Current static firing operations for gathering performance data release all exhaust effluent into the open air. These emissions include acid gases and particulate matter. Impending EPA regulations under the Clean Air Act Amendments of 1990 will promulgate regulations on rocket motor test firings.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Phase I Issue Phase I report (7-Pound Tests)
- Phase II Contract Monitoring of Phase II Design
- Phase II Quarterly design review for Phase II
- Phase II Complete 70-Pound Pilot-Scale Design
- Verify accurate thrust measurement while scrubbing exhaust
- Remove HCL from composite motors (98%)
- Remove particulate matter (98% above 1 micron)

ANNUAL PERFORMANCE REVIEW: Project was delayed 8 months due to test problems that have now been corrected.

PROJECT SUMMARY**TITLE:** User's Data Package (UDP) for Dust Suppressants**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The objective is to prepare a User's Data Package to address pertinent details related to the usage of polymer type and lignosulfonate type dust suppressants. Numerous dust suppression products, particularly polymer type and lignosulfonate type dust suppressants, have been the focus of recent field studies within the DoD. Aside from basic product information provided by various manufacturers of dust suppressants, a prospective user is faced with researching a multitude of details related to the usage of dust suppressants. Some of these details include soil characterization, product suitability, environmental safety, regulatory requirements, product selection, site planning, equipment required, product application, maintenance, and methods of product testing and evaluation. Prospective users are faced with a costly and time-consuming effort of researching the wide variety of available dust suppression products and implementation details for a specific soil region and application requirement. Results from recently completed studies on dust suppression products conducted at Marine Corps Air Ground Combat Center, CA, Fort Hood, TX and Fort Sill, OK, will be leveraged to develop a User Data Package (UDP) for the use of polymer type and lignosulfonate type dust suppressants.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Research regulatory issues
- Develop UDP outline
- Conduct literature review
- Prepare draft UDP

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

COMPLIANCE:

**HAZARDOUS/INDUSTRIAL WASTE DISPOSAL
AND TREATMENT**

PROJECT SUMMARY**TITLE:** Advanced IWTP Cyanide Management**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The main objective is to conduct a demonstration of cyanide wastewater treatment using advanced reverse osmosis (ARO) in conjunction with electrolytic metal recovery and anodic cyanide destruction of the ARO concentrate at NUWC Keyport IWTP. The Navy performs electroplating at approximately 15 facilities supporting repair operations for aircraft, ships, weapons, and communications systems. The plating facilities use caustic cyanide solutions to plate metals such as cadmium, copper, zinc, silver, and gold. The Navy metal finishing processes, used for electroplating a variety of Navy parts and in manufacturing printed circuit boards, annually generate over 235,000 tons of heavy metal-laden wastewater with an associated treatment and disposal cost of nearly one million dollars.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Complete site preparation and ARO system installation
- Conduct vendor performance testing of pilot scale electrolytic recovery unit (ERU)
- Procure and install full scale ERU
- Conduct operational testing
- Effluent must meet pretreatment discharge limits for cyanides and heavy metals

ANNUAL PERFORMANCE REVIEW: All performance objectives were met.

PROJECT SUMMARY

TITLE: Biodetoxification of Oily Sludges

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this effort is to develop and demonstrate a biological reactor to reduce disposal costs of oily sludges generated from Navy oily waste treatment facilities. The goal is to design a suitable biological reactor configuration populated with rugged microorganism strains that will exhibit good resistance to wild strain infections while furnishing effective performance characteristics. Navy facilities generate thousands of tons of oily sludges at oily wastewater reclamation facilities, shipyards, depots, and other maintenance activities dealing with oily waste. Land disposal is expensive and an environmental liability. Biological treatment can be effective and because of cost, may prove more desirable for meeting regulatory requirements than chemical or physical techniques.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Conduct lab treatability tests and optimize design parameters
- Design and install pilot system

ANNUAL PERFORMANCE REVIEW: Installation of the pilot system at the field site is rescheduled for 03/00 due to delays from regulatory approval required for in-house shakedown and operational tests.

PROJECT SUMMARY**TITLE:** Contaminated Blast Media**BUDGET ACTIVITY:** 2**PROGRAM ELEMENT:** 0602720A**IS THIS A CONGRESSIONAL INTEREST ITEM:** No.

DESCRIPTION: Various types of blast media are used to strip surface coatings during the refurbishing of military equipment. The media become contaminated with hazardous materials originally used during manufacture. The contaminated blast media is considered hazardous waste with high disposal costs. The Army currently spends excessive funds for disposal of contaminated blast media as hazardous waste. Technology is needed to reduce hazardous waste disposal of contaminated blast media.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Engineered abrasive/blast pretreatment feasibility lab study

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: Decontamination of Surfaces by Direct Oxidation

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Navy is presently decommissioning ships at a rate unequaled since the close of World War II. Many of these ships contain polychlorinated biphenyl (PCB) contaminated materials. PCB contaminated materials are a closely regulated toxic waste that costs the Navy about \$5 million per year to dispose. This task will develop a process to destroy PCBs on the surface of the material to avoid a secondary waste stream and reduce decontamination and disposal costs

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete laboratory tests on surrogate wastes
- Conduct bench-scale PCB destruction tests with actual wastes

ANNUAL PERFORMANCE REVIEW: FY99 objectives and milestones were not accomplished. The pulsed streamer corona discharge technology was not capable of destroying surrogate wastes. The task was terminated.

PROJECT SUMMARY

TITLE: Demonstration of Removal, Separation and Recovery of Heavy Metals from Industrial Wastestreams Using Molecular Recognition Technology (MRT)

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Hydroxide or sulfide precipitation is the conventional method for removal of heavy metals by industrial wastewater treatment plants (IWTP). To avoid formation of hazardous sludge by these precipitation methods, alternative metal adsorption technologies that produce purified heavy metals have been developed. This ESTCP project is intended to demonstrate the efficiency and uniqueness of molecular recognition technology (MRT) as a means to remove metal ions, and its separation and recovery capability when applied to Department of Defense (DoD) IWTPs.

The MRT system, which uses macrocyclic chelating ligands, was chosen due to its unique removal, separation and recovery of metals. By taking advantage of the high affinity and selectivity of these ligands, MRT systems can be designed to target the toxic metals found in DoD industrial influents. These specialized ligands are bonded to polymer supports and are very stable in the solid form. This allows the ligands to be used in a packed bed or membrane configuration at the high flow rates required by typical DoD IWTPs. This demonstration will use the high volume acid/alkali influent wastestream at Puget Sound Naval Ship Yard's (PSNSY) industrial wastewater treatment facility to show MRT's significant advantage over conventional metal removal technologies.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Meet with Washington State Regulators
- Complete Final Dem/Val Plan
- Arrival of MRT Skid
- Install MRT System
- Modification of MRT Skid
- Perform Cost Analysis Evaluation

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Electrochemical Oxidation of Energetic Waste

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this effort is to evaluate Cerium-Mediated Electrochemical Oxidation of energetic materials and its potential as an alternative to open burning. The Navy generates waste propellant, explosives, and pyrotechnics (PEP) at several sites from manufacturing and Demil operations. Currently, the technology for a Confined Burn facility is still being developed and demonstrated. The need exists to look at complementary technologies that might be able to treat some of the waste streams intended for Confined Burn at a reduced capital and operating cost and thus reduce the overall facility costs associated with waste treatment at Navy sites.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Complete site preparation and system installation
- Prepare Test Plan
- Prepare Standard Operating Procedures for Cerium Oxidation System
- Obtain permits
- Conduct mass balance experiments for inert and liquid energetic materials

ANNUAL PERFORMANCE REVIEW: Met all performance objectives..

PROJECT SUMMARY

TITLE: Hazardous and PCB Contaminated Material Recycling at PSNS Using MMT CEP Technology

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this effort is to evaluate, validate, and deploy Molten Metal Catalytic Extraction Process (CEP) technology for recycling hazardous and PCB contaminated materials generated at Puget Sound Naval Shipyard (PSNS) and other DoD facilities located in the Pacific Northwest. This will then reduce the cost and eliminate the liability associated with the management, treatment, and disposal of these wastes. DoD facilities in the Northwest Region generate hazardous and PCB contaminated wastes that are costly to handle and dispose of.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Monitor technology status and recommend project continuation or termination based on findings.
- Issue initiation decision and project status report
- Confirm continued availability and viability of CEP technology based on the outcome of Chapter 11 Bankruptcy by the technology provider

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Kinetics of Supercritical Water Oxidation

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project was to develop a supercritical water oxidation (SCWO) technology to treat aqueous wastes. SCWO is an emerging technology under development for the treatment of hazardous wastes such as obsolete chemical munitions, mixed wastes, and naval shipboard excess hazardous materials. Understanding of the rates and mechanisms of reactions in supercritical water was limited to a handful of empirical rate expressions for very simple chemicals. These expressions were of limited use in the formulation of predictive models of SCWO for the design and operation of large-scale waste processing equipment. To be applicable as design tools, the models needed to be based on elementary reaction steps or, at minimum, a detailed quantitative mechanistic description incorporating all the key fundamental reactions. Basic research was needed to improve the ability to predict reaction rates in supercritical water.

The project was designed to result in a user-friendly, computer-based model that could predict reaction rates and conversion efficiency for a wide range of waste feeds and reactor conditions. The development of this model and its application to the specifics of the PBA plant provides three benefits. The first is short-term and will have a direct impact on the efficiency of that plant, as it is transitioned from a demonstration /validation unit to part of the Army's demil capability for unusual materials. The second benefit is longer term and applies not only to the development of SCWO within the transpiration-wall strategy, but to any feed system that relies on autothermal initiation of the reactants. Both the 2-D and 3-D work proposed here contribute to the improvement and safety of injector configurations for SCWO reactors that use other methods to mitigate corrosion and scaling (i.e. methods that employ liners of special materials and high flow velocities). The third benefit will be the guidance that can be gained from modeling regarding scaling issues.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Add real gas equation of state to CURRENT
- Achieve convergence of CURRENT simulation of EER 1-propanol and methanol oxidation data
- Develop mixing/transport model
- Create CFD grid
- Choose 3-D code to conduct simulation
- Achieve convergence in 3-D simulation
- Complete grid for PBA system
- Achieve convergence and agreement with observation for PBA operation on 2propanol and sugar testing
- Determine reduced kinetics for PBA simulation
- Decide on transpiration flow approximation strategy
- Incorporate transpiration wall into EER and PBA models and reproduce experimental PBA surface temperature
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Plasma Arc Destruction of Hazardous Waste

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The purpose of this project is to design, build and demonstrate a plasma arc hazardous waste treatment system (PAHWTS) at a U.S. Department of Defense (DoD) facility that will be capable of converting hazardous wastes to benign gases and solids.

Approximately 2 million pounds of hazardous waste (HW) are processed and disposed of by Norfolk Naval Base each year at an average cost of \$1.30 per pound, representing a total cost of about \$2.6 million. The naval base currently hires a contractor to transport the waste to either a HW landfill or to an incinerator. Prototype plasma arc processing systems have been shown to destroy HW, but currently there are no production-scale systems operating in the United States. A plasma arc operates on the same principle as lightning, but, in this case, a device called a plasma torch maintains a continuous “lightning bolt” inside a protective chamber. Waste material is fed into the chamber and the intense heat of the plasma breaks down organic molecules (such as oil, solvents, and paint) into their basic atoms. By carefully controlling the process, these atoms recombine into harmless gases such as carbon dioxide. Solids such as glass and metals are melted to form a material similar to hardened lava in which toxic metals are encapsulated. With plasma arc there is no burning or incineration and no formation of ash. This project will design, construct, and install a plasma arc system capable of destroying more than 1.5 million pounds of HW each year. The system will be equipped with continuous air emission monitors to ensure that no harmful gases are released.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete Assembly of PAHWTS at Retech
- Notice of Availability published in Federal Register

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Removal, Treatment, and Disposal Technologies for Lead-Based Paint (LBP) Contamination

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603728A

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Three important Federally driven programs related to this requirement are (1) prevention of childhood lead poisoning, (2) prevention of over-exposure of workers to lead, and (3) characterization and proper disposal of lead-contaminated debris. Routine maintenance, interim control, or abatement of sources of lead are inefficient, costly, and can often result in exposure of children and workers to lead as well as contamination of the environment through improper controls during abatement and disposal. The cost of managing or abating lead sources is prohibitive, especially considering the large stock of older Army facilities, and often results in work not being affordable. Army property owners need cost-effective technologies to control or abate sources of lead exposure and contamination and to safely remove, describe, handle, store, transport, and dispose of lead-contaminated debris. Lead-contaminated paint, dust, and soil are common in and around Army residential properties, child support facilities, and wooden structures constructed prior to 1978. In addition, numerous steel structures such as towers, tanks, bridges, piers, locks, and dams were constructed using lead-based paint primers and lead-based paint coatings. The Army needs a standard methodology for fast assessment techniques, a standard methodology for managing LBP in place, and environmentally safe and cost-effective removal and disposal or reuse of lead contamination sources.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Pilot test Microwave Applicator with chemical stabilizer
- Lab test self-healing coatings to reduce hazardous lead dust
- Pilot test lead-based paint hazard management system
- Develop overcoatings selection criteria for lead-based paint

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: T-56 Engine Gas-Path Wastewater Treatment

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to demonstrate the performance of the Navy developed Closed Loop Aircraft Washrack Wastewater Recycle System (CLAWWRS) for removing cadmium and other heavy metal pollutants from aircraft engine gas path cleaning wastewater. The Navy conducts cleaning operations on aircraft compressor engines known as “gas path cleaning.” The Navy has found that cleaning certain engine types, specifically the T-56 found on such aircraft as the C-130 and P-3, generates a waste stream high in cadmium. Aircraft gas path cleaning generates from 50 to 100 gallons wastewater per aircraft engine washing. Wash crews are currently required to collect this gas path wastewater separately from the aircraft exterior wash and dispose of it as a hazardous waste. The CLAWWRS is designed to treat and recycle wastewater from aircraft exterior washing operations. This system will be modified to provide the capability to remove the larger quantities of cadmium found in gas path cleaning wastewaters.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Conduct survey of gas path cleaning treatment and management practices
- Perform bench scale tests to optimized process modifications
- Procure components and conduct system modifications

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Treatment Techniques for Wastewater from Munitions Production

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Munitions production is threatened by ever more stringent environmental regulations. To maintain mission readiness for munitions production, the Army needs treatment technologies for munition wastewaters from Load, Assembly, and Pack (LAP), and demilitarization operations. The primary technology focus area is wastewater from TNT (Pink Water), RDX, HMX, and TNB LAP operations at AMC installations. The current treatment for Pink Water is Activated Carbon or sand and Anthracite coal. The spent carbon must either be incinerated or regenerated, both of which are expensive. Activated carbon regeneration is often steam-based and can present safety issues.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop 2-step biological treatment process anaerobic transformation followed by aerobic mineralization
- Develop thermal plasma techniques for pyrolytic destruction of organic energetic wastes and the vitrification of heavy metal bearing

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: Zero Discharge Industrial Wastewater Treatment Plant (IWTP)

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This task will develop and integrate technologies that will be needed by the Navy's Industrial Wastewater Treatment Plants (IWTPs) of the 21st century so they can comply with the Clean Water Act (CWA) and other regulatory requirements. It will identify and optimize the technical parameters of advanced technologies to remove and recover heavy metals, to mineralize organic compounds, and to polish the effluent so that industrial wastewater can be recycled.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Field test Ultrasonic AOP for proof-of-concept for surfactants
- Field evaluation of Molecular Recognition Technology and transition to ESTCP
- Transition of Advanced Reverse Osmosis technology to pilot-scale demo
- Complete IWTP Process Integration and transition documentation

ANNUAL PERFORMANCE REVIEW: Met all performance objectives. This project was completed and transitioned to ESTCP and Advanced Development Programs for DEM/VAL and certification.

PROJECT SUMMARY**TITLE:** Asbestos Removal**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** Yes.

DESCRIPTION: The objective of this project is to evaluate a thermochemical process that mineralogically converts hazardous wastes: asbestos-containing material (ACM) contaminated with polychlorinated biphenyl's (PCBs) to inert stable non-hazardous material. This technology was demonstrated at the Puget Sound Naval Shipyard (PSNS) as a result of a congressionally mandated Broad Agency Announcement (BAA) award. The Navy is required to properly dispose of hazardous PCB-ACM waste generated from facility abatement, ship maintenance, submarine deactivation, other waste streams, and repair projects. A practical solution to this complex problem resides in a thermochemical conversion system. Waste is sprayed with an alkaline mineralizing agent and sufficiently heated to convert PCB-ACM into non-hazardous material. The system uses a rotary hearth furnace to vitrify PCB-ACM, and an afterburner destroys other remaining contaminants. Waste reduction is approximately 90%. Cradle-to-grave liabilities are terminated, because all regulated wastes are consumed. The thermochemical process is a cost effective environmentally feasible alternative to landfill disposal, endorsed by the United States Environmental Protection Agency (EPA). The PCB-ACM Conversion System meets all requirements of the National Emission Standard for Hazardous Air Pollutants (NESHAP) for asbestos conversion processes (40 CFR 61.155) and complies with (29 CFR 1910) OSHA Health & Safety Standards. This project will provide an alternative to the land filling of asbestos removed from PCB contaminated asbestos of deactivated submarines as well as larger quantities, but less contaminated asbestos from closed facilities.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Design, fabricate, and test a second-generation system based on the results of FY98-funded testing

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Plasma Energy Pyrolysis System (PEPS)

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: PEPS addresses the need for alternatives to Open-Burning/Open-Detonation (OB/OD) under an Army requirement. This project will: address military-unique hazardous waste and components disposal problem; relieve restrictions on OB/OD application; provide a one step treatment and disposal technology; and demonstrate a mobile system for small field applications.

The approach includes an assessment of impact of mobility on integrity of the PEP unit, an evaluation of the unit's operational performance under field conditions; and verification of emissions/slag compliance with EPA Resource Conservation and Recovery Act (RCRA) limits.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete mobile PEPS design and deliver design report
- Complete National Environmental Policy Act (NEPA) review document and initiate permitting activities
- Complete test plan document including delivery of safety and health plan

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: Wastewater Technology Test Bed

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: Ship repair, conversion, dismantling, and naval support activities at Puget Sound Naval Shipyard generate a complex and diversified series of waste streams, including oily bilge water and industrial wastewater. This project establishes a Wastewater Technology Test Bed to identify, test, and verify the performance of technologies, processes, sensors, and management practices to reduce, manage, recover, recycle, or treat complex bilgewater and industrial wastewater waste streams, concentrating on “problem” waste streams that are not easily treated by conventional technology.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Needs Assessment Review
- Technology Survey
- Validation Test Protocol
- Validation Test Report
- Cost/Benefit Analysis
- Final Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

COMPLIANCE:

NOISE IMPACTS AND CONTROL

PROJECT SUMMARY

TITLE: NO_x And Noise Reduction from Jet Engine Test Cells

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this effort is to quantitatively evaluate alternative Jet Engine Test Cell (JETC) chemical and noise emissions control strategies and technologies. Systems that are both technically and economically feasible will be experimentally assessed on a Navy test cell. Navy JETCs are currently operating with no mechanisms for reduction of chemical or particulate emissions. In addition, noise emissions from the Navy's standard JETC and most other test facilities are exceeding their design limits.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Conduct emissions reduction tests using the JETC test rig
- Evaluate selective non-catalytic reduction (SNCR) for NO_x removal
- Examine water injection techniques
- Evaluate passive noise attenuation
- Prepare technology assessment report
- NO_x reduction methods need to reduce emissions by ~50% without effecting engine performance
- Noise reduction alternatives need to need to decrease far field noise emissions by > 5 dB

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

COMPLIANCE:

SHIPBOARD SOLID/LIQUID WASTE DISPOSAL

PROJECT SUMMARY**TITLE:** Advanced Oil Spill Response Equipment**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The project objective is to demonstrate new equipment prior to procurement and development of ancillary equipment that will improve response time and increase the service life of oil spill response equipment currently in the Navy inventory. In order to minimize the release to the environment during oil spill events and comply with pertinent regulation, the Navy maintains a \$125M inventory of oil spill response equipment that requires an additional \$7M-\$10M annually to update and replace. Development and demonstration of advanced oil spill equipment will improve the performance, response time, and service life of the Navy's oil spill response equipment. This work is particularly important since private sector development of oil spill response equipment has focused on response to heavy crude oil spill at sea. The vast majority of Navy spills involves lower molecular weight hydrocarbons such as JP-5, diesel fuel marine, and Navy distillate and most often occurs in port. Therefore, the performance of available equipment for the typical Navy oil spill cannot be predicted based on existing crude oil data.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Review oil spill data, regulations, and equipment specifications to determine requirements

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Aerated Non-Oily Wastewater Membrane Treatment System Demonstration

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This task will demonstrate, pier- side, a hybrid membrane/bio-conditioning system that will treat shipboard generated blackwater and graywater to a level that will meet anticipated national and international effluent discharge standards of biochemical oxygen demand (BOD5) < 50 mg/L, total suspended solids (TSS) <100 mg/L and fecal coliform (FC) <200/100 ml. The unit will process actual shipboard non-oily wastewater over a five-month period to demonstrate system reliability, performance and ability to handle unanticipated upsets (toxic shocks) during system operation. This task supports the CNO operational requirement for access to all navigable waters, world-wide, without being constrained by environmental protection regulations.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Conduct demonstration unit acceptance testing in the laboratory and at pier-side
- Conduct demonstration testing pier-side, test analysis and summary reporting
- Initiate transition documentation

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Bilgewater Treatment with Liquid Carbon Dioxide Extraction

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Parallel plate oil/water separators (OWS) that are being installed aboard Navy ships remove more than 90% of the oil in bilgewater. However, the oil concentration in the discharge from the OWS does not always meet the 15-ppm discharge requirement. Ultrafiltration membranes have been shown in recent shipboard evaluations to remove oil to less than 10 ppm. But, anticipated regulations may require less than 5 ppm in restricted zones and harbors. This task will investigate the feasibility of using liquid CO₂ to extract oil from the OWS effluent to reduce its concentration well below 1 ppm.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Design laboratory demo unit to treat surrogate bilgewater
- Conduct laboratory bench-scale evaluation

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Collection and Treatment of Compensated Fuel Ballast Water

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of the task is to develop and demonstrate an effective compensating ballast water (or compwater) collection and treatment system for shoreside discharge to sanitary sewer. Ships with water compensating fuel system (WCFS) are not allowed to discharge compensating ballast water overboard in some navy ports. Navy ship destroyers (e.g. Spruance and Kidd class) and cruisers (Ticonderoga class) are designed with WCFS to enhance ship's stability. During refueling, fuel displaces the compensating ballast water inside the fuel tanks directly through the ship's overboard discharge ports. The compwater poses an environmental risk due to the presence of small amount of fuel oil. Currently, Alaska, Washington (Puget Sound), Canada (Esquimalt), and some parts of the East Coast have "zero discharge" standard and do not allow ships with WCFS to refuel in-port unless the compwater is collected for processing ashore. There are currently no standard methods for the collection and treatment of compwater onshore. Large volumes and high discharge rates of compwater can be encountered during ship's refueling evolution making this problem unique and challenging. The proposed system will utilize a barge to collect the compensating ballast water from ships and an oil water separation system (barge mounted) to remove the fuel oil prior to discharge in a sanitary sewer. This system is being implemented and is an interim solution at the NAVSTA Everett where current regulations mandate zero-discharge into local waters. UNDS program and its final ruling will ultimately determine the type of marine pollution device (onboard system, operational procedure changes or exemption) for Navywide application.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Design collection and treatment system
- Procure system components
- Fabricate and perform shakedown tests

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Electrochemical Advanced Oxidation Process for Shipboard Final Purification of Filtered Black Water, Gray Water, and Bilge Water

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The overall objective of this project is to advance development of an electrochemical Advanced Oxidation Process (AOP) which will be used as a final polishing step following membrane filtration of shipboard wastewater. To comply with International Maritime Organizations Marine Pollution Convention (MARPOL) Annex V and other environmental regulations, U.S. Navy vessels require compact, energy efficient water purification technology which will allow most of the wastewaters produced on board (bilge, gray, black, etc.) to be discharged overboard following purification. Membrane filtration does not achieve the degree of purification required, and a final “polishing” process is needed prior to discharge overboard. The specific objectives of this project include producing AOP electrodes with improved service life and improved performance at low substrate concentrations, developing methods for reprocessing the electrodes, and identifying optimal operating conditions for the AOP.

Existing equipment for producing small test electrodes in the laboratory will be upgraded. An apparatus permitting long-term testing of the electrodes will be developed, and a correlation of service life vs. current density will be determined. Tests will be developed to evaluate the kinetics of different oxidation mechanisms for several substrates. X-ray diffraction, scanning electron microscopy, and specialized surface analyses will be used to characterize the crystal structure, surface morphology, and surface composition of the electrodes. Fiber made of the alloy Ti-6Al-4V (aerospace titanium) will be procured and evaluated for service as an electrode substrate. This alloy is expected to decrease the brittleness of the porous anodes produced, and thereby allow reprocessing of used-up electrodes at a fraction of replacement cost.

This technology is cooperatively funded by SERDP and the Navy (see p. B-72).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Specify reprocessing method for Ti-Gr.1 fiber
- Measure electrical properties of oxide coat
- Begin operation of theoretical model of electrode function
- Specify slurry coating procedure
- Specify sealing procedure for oxide coat
- Select improved cathode composition
- Specify precoating procedure
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Electrochemical Treatment of Nonoily Wastewater

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Navy is developing shipboard nonoily wastewater treatment systems to meet anticipated US EPA and international discharge requirements. The treatment technology will use polymeric ultrafiltration (UF) or microfiltration (MF) membrane technology to treat nonoily wastewater. However, UF and MF membranes cannot remove enough of the five-day biochemical oxygen demand (BOD₅) to meet anticipated discharge requirements. This task will demonstrate the feasibility of using electrochemical oxidation in conjunction with UF/MF membranes to remove BOD₅ and ensure consistent disinfection to meet anticipated water quality standards.

This technology is cooperatively funded by the Navy and SERDP (see p. B-71).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Conduct laboratory evaluation of SONOMA prototype
- Conduct laboratory evaluation of ELTECH electrochemical unit

ANNUAL PERFORMANCE REVIEW: FY99 objectives and milestones were not accomplished. The SONOMA and ELTECH electrochemical generators were not delivered due to electrode materials problems and manufacturing problems respectively. The task was terminated.

PROJECT SUMMARY

TITLE: Hazardous and Other Ship Wastes – Oil Spill Response

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective is to develop and improve, as necessary, Navy oil spill response systems pursuant to the Oil Pollution Act of 1990 (which mandates Navy capability to respond to large-scale worst-case oil spills and requires specific oil-spill response equipment levels based on mechanical cleanup), OPNAVINST 5090.1B (which assigns these responsibilities to Supervisor of Salvage and Diving (SUPSALV)), and states (e.g., Alaska) that require various levels of equipment readiness and cleanup durations). Navy oil spill response systems encompass equipment (oil skimmers, oil containment booms, oil storage bladders, oil transfer systems, ancillary support gear, specialized items) and various computerized tools for contingency planning and asset tracking. Current efforts focus on in-situ burn techniques, oil outflow and salvage analysis, recovered oil logistics, and computer-based contingency planning.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Test new fire boom blanket candidates
- Complete modeling and naval architecture features of the computerized oil outflow and salvage response program
- Complete development of a prototype barge and transfer system for recovered oil transfer and shallow-water operations
- Formulate material transfer system concepts for transferring pollution response and offload equipment onto stranded vessels
- Define steam generator requirements for a portable heating system
- Complete development of the Computer Assisted Planning and Emergency Response System (CAPERS) for site-specific spill contingency planning and management of response operations

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Integrated Liquid Wastes – Shipboard Fuel Compensated Ballast Discharge

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective is to develop operational and design modifications and guidance that will reduce the unintentional discharge of oil (fuel) from shipboard compensated fuel ballast systems during refueling and to significantly reduce water hideout (and thus minimize lost fuel capacity). This will allow ships with compensated systems to comply with current and anticipated national and international oil discharge standards, including the Clean Water Act (especially its Uniform National Discharge Standards provisions), USCG regulations, and Annex I of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). Section 325 of the National Defense Authorization Act for Fiscal Year 1996 amended the Clean Water Act to establish Uniform National Discharge Standards (UNDS) for vessels of the Armed Forces; “compensated fuel ballast” was identified by the joint DoD/EPA rule as an UNDS ship discharge that will require a Marine Pollution Control Device (MPCD). This effort encompasses computational fluid dynamics (CFD) simulation, structural analysis, and testing with a range of small- to full-scale physical tank models to understand refueling processes and evaluate possible structural modifications to fuel tanks and changes to refueling procedures.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Refine the CFD model by incorporating flow and mixing computer submodels and experimentally obtained oil droplet size and distribution data
- Continue structural analysis of the effects of additional flow openings in tanks on hull stress and fatigue
- Complete construction of the small model test facility and initiate testing

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Integrated Liquid Wastes – Shipboard Integrated Liquid Discharge System

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objectives are to develop a shipboard Integrated Liquid Discharge System (ILDS) that incorporates the thermal destruction of concentrated oily waste, concentrated blackwater, concentrated graywater, and waste oil and prepare system performance and interface specifications. This will allow Navy ships to comply with existing and future discharge restrictions (especially the Clean Water Act and Annexes I and IV of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)) that apply to blackwater, oily wastes, and graywater, while enhancing operational flexibility and reducing shore dependency and waste disposal costs.

This technology is cooperatively funded by the Navy and SERDP (see p. B-88 and B-90).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Establish a thermal destruction laboratory facility consisting of a fully-instrumented liquid waste incinerator, connections to developmental oily waste and non-oily wastewater membrane-filtration (concentration) systems, and comprehensive air emissions monitoring equipment

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Integrated Liquid Wastes – Shipboard Non-Oily Waste Treatment

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objectives are to develop a shipboard membrane-filtration system to treat non-oily wastewater (sanitary, hotel, and commissary liquid wastes) on surface ships to meet federal and international discharge regulations and prepare system performance and interface specifications. This will provide Navy vessels with the capability to operate in environmentally restricted areas by meeting current and anticipated national and international effluent discharge standards, including the Clean Water Act (especially its Uniform National Discharge Standards provisions), USCG regulations, and Annex IV of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). Section 325 of the National Defense Authorization Act for Fiscal Year 1996 amended the Clean Water Act to establish Uniform National Discharge Standards (UNDS) for vessels of the Armed Forces; “graywater” was identified by the joint DoD/EPA rule as an UNDS ship discharge that will require a Marine Pollution Control Device (MPCD). The environmental compliance requirements for this project are identified in the Tri-Service Environmental Quality Strategic Plan as: DoD Pillar 2, Thrust 2.B.2, Water-Organic/Metals-Ship Non-Oily; Requirement 2.II.1.g, Control and Management of Shipboard Non-Oily Waste.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Conduct 450-hr and 930-hr performance evaluations of the Engineering Development Model (EDM) membrane treatment system in the laboratory, simulating various ship deployment scenarios in regulated waters and in port

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Integrated Liquid Wastes – Shipboard Oil Content Monitors

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective is to develop an advanced Oil Content Monitor (OCM) that can consistently measure the oil content of Oil/Water Separator (OWS) effluent down to 15 ppm oil to meet the oil discharge restrictions of the Clean Water Act and Annex I of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) as implemented by the Act to Prevent Pollution from Ships and Chief of Naval Operations' policy (OPNAVINST 5090.1B). The advanced OCM will be significantly more accurate and reliable, as well as easier to calibrate, than the Navy's existing shipboard OCMs.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Evaluate candidate commercial OCMs in the laboratory
- Identify and initiate testing of enhancements to the Navy's existing OCM that could significantly improve its performance

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Integrated Liquid Wastes – Shipboard Oily Waste Treatment

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objectives are to develop a shipboard membrane-filtration system to treat oily waste on surface ships to meet federal and international discharge regulations and prepare system performance and interface specifications. The treatment system will be installed downstream of existing Oil/Water Separators (OWSs). This will provide Navy vessels with the capability to operate in environmentally restricted areas by meeting current and anticipated national and international effluent discharge standards, including the Act to Prevent Pollution from Ships, Clean Water Act (especially its Uniform National Discharge Standards provisions), USCG regulations, and Annex I of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). Section 325 of the National Defense Authorization Act for Fiscal Year 1996 amended the Clean Water Act to establish Uniform National Discharge Standards (UNDS) for vessels of the Armed Forces; “surface vessel bilgewater/oil-water separator discharge” was identified by the joint DoD/EPA rule as an UNDS ship discharge that will require a Marine Pollution Control Device (MPCD). Three design variations are being developed: a 10-gpm system for forward-fit and potential backfit on medium-size surface combatants, a 50-gpm system for forward-fit and potential backfit on large surface combatants, and a 5-gpm combined bulk-oil-separator/membrane-filtration system for forward-fit on medium-size surface combatants.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Continue to support the 10-gpm Engineering Development Model (EDM) system installed on USS CARNEY (DDG-64)
- Install a 10-gpm EDM system on USS RUSHMORE (LSD-47)
- Complete the design of a 50-gpm laboratory EDM system and initiate testing
- Complete laboratory testing of alternative bulk-oil separators to be used in the 5-gpm combined system and initiate system concept development

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Integrated Liquid Wastes – Uniform National Discharge Standards

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective is to support the joint DoD/EPA rulemaking program to develop shipboard Marine Pollution Control Devices (MPCDs) for Navy and other Armed Forces vessels, as required by Section 325 of the National Defense Authorization Act for Fiscal Year 1996 that amended the Clean Water Act. The Navy has the DoD lead for this program. MPCDs are equipment or management practices to control liquid effluents other than sewage (blackwater).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete the joint Phase I rule that identifies the shipboard liquid discharges that will require MPCDs where reasonable and practicable (based on nature of discharge, environmental effects, practicability of using an MPCD, effect of MPCD installation & use on the operation or operational capability of a vessel, U.S. laws and international standards, and the cost of MPCD installation and use)
- Initiate the Phase II development of MPCD performance standards, which can reflect distinctions among vessel class, type, size, and age

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Neural Network Algorithm for Oil Content Monitors

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The technical objective of this task is to demonstrate the on-line use of a neural network spectral pattern classification algorithm that uses a fluorescence-based oil content monitor (OCM) to accurately quantify total petroleum contamination (fuels, oils, and lubricants) in the effluent from shipboard oily-wastewater treatment systems (OWTS) to 15 PPM or less, even in the presence of interfering chemicals. If successful, the classification algorithm will be integrated with shipboard OCMs.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Characterize OWS contaminants and spectral features
- Develop and test artificial neural network (ANN) for classification of OWS fluorescent spectra

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Nonfouling Coatings for Ceramic Membranes

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Ceramic ultrafiltration membranes are being used in shipboard advanced oily wastewater treatment systems (OWTS) to remove trace amounts of oil and potentially toxic organic constituents from shipboard oil/water separator (OWS) effluent. Membrane fouling is the most significant problem encountered and causes a significant maintenance burden. This task will develop and test several fouling resistant coatings that can be applied to existing ceramic membranes used in the shipboard OWTS. The goal is to substantially reduce fouling and membrane cleaning requirements and, thus, maximize the operational life of the ceramic membranes.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Test back pulsing on coated ceramic membranes
- Test back pulsing on uncoated ceramic membranes
- Finalize coating process

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Novel Nonporous Fouling - Resistant Composite Nanofiltration Membranes and Membrane Separation Systems for Wastewater Treatment

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop a shipboard wastewater treatment system based on a novel type of fouling-resistant, composite-membrane module. The composite membrane will consist of an ultrathin (0.2-0.5 micrometer), nonporous, highly water-permeable, rubbery, block copolymer layer coated on to a conventional, microporous ultrafiltration or nanofiltration membrane for support. This coating layer provides fouling resistance without significantly reducing the water flux. Development of three membranes will be completed and a systematic series of new materials will be synthesized and characterized. The properties of these new heterophase block copolymer membrane materials will be tailored to provide better fouling resistance than conventional membranes while maintaining or improving the flux/selectivity combinations relative to currently available materials. These materials will be based on aromatic polyamide hard blocks with either hydrophilic ether groups as the soft, water-permeable block or water-soluble aromatic polyamides as the hydrophilic blocks. This research program will characterize the physical, chemical, and morphological structure of these materials as well as their water permeation, rejection, and fouling properties to develop systematic structure/property relations to guide the preparation of a new generation of advanced high performance materials for shipboard wastewater treatment. The best membrane materials will be selected for scale-up to bench-scale and then to industrial-scale modules for evaluation in a pilot-scale system.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Scale up synthesis of polymers from poly(sulfoisophenyleneisophthalamide)-b-poly(m-phenyleneisophthalamide) to 10-20 g for composite membrane preparation
- Prepare thin-film composite membranes from commercial polyether-polyamide block copolymers and from polymers supplied by NC State University
- Determine water flux and rejection properties of composite membranes with a variety of solutes in short-term experiments
- Determine fouling resistance of composite membranes with oil/water emulsions in long-term tests (7-14 days)
- Characterize water permeability and rejection properties of poly(ethylene oxide) and poly(sulfoisophenyleneisophthalamide) based copolymers
- Determine chemical stability of composite membranes (pH and chlorine resistance)
- Prepare most promising membrane on commercial-sized coating equipment
- Prepare microporous support membrane on commercial-sized casting equipment.
- Evaluate fouling resistance of bench-scale modules with oil/water emulsions
- Prepare bench-scale 2" diameter spiral wound modules of 1 square meter of area
- Establish optimum process conditions for minimum module fouling
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Performance Enhancing Biomolecular Treatment Strategies for Naval Graywater Filtration Systems

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This task is part of a three-way collaboration with the Rensselaer Polytechnic Institute, the University of California-Berkeley and the Naval Research Laboratory. This task will develop, prepare and integrate new biofilter membrane technology for increasing service lifetime and efficiency of ultrafiltration shipboard systems and reducing maintenance. These membranes will incorporate enzymes useful in preventing the build up of foulant materials. Appropriate enzymes will be identified and several enzyme incorporation techniques will be evaluated including a hydrogel coating with enzyme(s) incorporated within the gel network.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete physical adsorption, covalent attachment and chemical attachment via polyvinyl alcohol (PVA) for enzyme immobilization
- Initiate biocatalytic film coating of current microfiltration modules for testing in lab

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Pierside Oil Spill Detection**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The objective of this project is to develop and demonstrate an automated oil spill monitor/alarm system providing real-time notification of petroleum leaks and spills in port. The oil spill detection methods currently being practiced at most marine facilities rely solely upon the use of human visual observation to identify the presence of surface sheen indicative of a petroleum spill. This practice has severe shortcomings. Spills often occur at unanticipated times or places in which no one is present to see and report the event. It is not uncommon for pipeline and container leaks to go undetected for many hours and sometimes days, allowing small leaks to accumulate into large volume spills before corrective action is applied. Visual observation is especially unreliable at night or during foul weather when it can be virtually impossible to see a sheen on the water. An all-weather, continuous real-time, automated oil-spill sensing system will enable responders to take immediate corrective action to stop and contain spills and thereby minimize clean-up cost and environmental damage.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Initiate Puget Sound Naval Shipyard Demonstration/Validation
- Complete transition of enhanced features to commercial partners through CRADA and licensing agreements
- Demonstrated the system will detect POL on water to 0.2 micron thickness
- Demonstrated the system can provide continuous quantitative and qualitative information under all weather/light conditions

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Plasma Arc Waste Destruction System (PAWDS)**BUDGET ACTIVITY:** 3**PROGRAM ELEMENT:** 0603792N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The overall objective of the Plasma Arc Waste Destruction System (PAWDS) Advanced Technology Demonstration (ATD) program is to establish high temperature plasma as a superior technology for the thermal destruction of Navy shipboard solid waste. The system is expected to provide at least 75X reduction in the solid waste volume, 50% reduction in system size versus currently available commercial systems and minimization of manning levels and training requirements. The capability to process a wide variety of waste streams will enable the US Navy to meet its goal of not discharging solid waste matter into the world's seas and will allow it to be in compliance with all international environmental laws.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Initiation of preliminary design of PAWDS system through the use of computer modeling and simplified laboratory scale tests of plasma/eductor designs
- Determination of the most suitable location for the land-based PAWDS demonstration unit
- Procurement of long-lead items required for construction of PAWDS demonstration unit

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Purification of Oily Wastewaters by a One-Step Advanced Biodegradation Process that Produces No Secondary Wastestreams

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Department of Defense uses thousands of oil-water separators (OWS) to remove oil from shipboard bilge water, aqueous streams at wash rack and Army maintenance facilities, Air Force central vehicle and aircraft wash down operations, and industrial waste treatment plants. In many cases, existing OWS cannot achieve increasingly stringent wastewater compliance requirements. Additionally, OWS require extensive maintenance to remove oil that accumulates on the plates of the separators and the oil that is separated from the waste stream has to be treated as a hazardous waste. The annual cost of maintaining the OWS and disposing of the separated oil has been estimated to be about \$65 million. For bilge water, the separated oil is retained on board ship for land disposal, consuming valuable ship space and weight. The objective of this program is to demonstrate a low maintenance biological process for on board treatment of bilge water to a quality that meets the MARPOL discharge provisions and in which the oil contaminants are completely degraded to carbon dioxide and water.

A new technique, forced molecular evolution, will be used to cultivate enhanced microorganisms needed for a robust, high throughput biological process with performance, size and maintenance characteristics suitable for shipboard deployment. The Naval Research Laboratory (Washington, DC) will collect mixed populations of organisms to provide a diverse starting microbial population for the forced molecular studies and will provide toxicity screening. Polytechnic University (Brooklyn, NY) will carry out the forced molecular evolution studies, while Tufts University (Medford, MA) will use genetic enhancement techniques to further optimize and tailor the degradation capability of the selected bacterial strains. Development of a novel bioreactor having high oxygen rates will be carried out by Foster-Miller (Waltham, MA). A pilot-scale bioreactor system will be developed and tested at a Naval facility. The program will first focus on the treatment of bilge water and then on the treatment of wash down and wash rack wastewaters. The final products will be the development of new techniques for the biodegradation of organically contaminated wastewater and a bioreactor test system that can be used to evaluate various DoD- and industrially-generated wastewater. Potential annual savings to the DoD are estimated to be about \$25 million. ESTCP demonstration/validation tests aboard Navy ships and at Air Force wash down and Army maintenance facilities are planned.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete diversification of initial microflora
- Complete collection of microorganism samples from Navy wastes
- Complete screening of microorganisms for pathogens
- Complete preparation of gene probes and primers
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: This project was delayed 6 months due to rescoping of the project.

PROJECT SUMMARY

TITLE: Shipboard Processes

BUDGET ACTIVITY: 1

PROGRAM ELEMENT: 0601153N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Basic research is being performed in a variety of S&T areas that will enable the fleet to reduce emissions through advanced processing of effluents and development of clean power and cooling sources. These areas include:

- Thermoelectrics: Develop new thermoelectric materials, structures and devices with performance significantly better than BiTe-based materials and provide a clean conversion of waste heat to electrical power.
- Thermoacoustics: Develop the basic understanding required to offer well-understood options for the configurations of practical thermoacoustic cooling systems as an alternative technology for Navy shipboard and other cooling applications and will reduce the dependence on and emissions from HFC-based cooling systems.
- Sensors: Develop new sensor technologies for the detection of pollutants and monitoring of ship effluents.
- Fuel Cells: Improve the performance of fuel cell systems operating on logistics diesel fuels by formulating sulfur-tolerant electrocatalysts using combinatorial methods and by developing electrochemical membranes for efficient removal of hydrogen sulfide from reformat streams.
- Membranes: Development of novel membranes that can be used in the treatment of waste streams and that will result in decreased fouling/maintenance and increased performance and lifetime.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Publication in peer reviewed literature to establish Navy proactive leadership and discovery in the S&T area

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Solid Waste – Shipboard Thermal Destruction

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objectives are to develop shipboard thermal destruction systems for disposing of solid wastes on surface ships and prepare system performance and interface specifications. Navy ships cannot hold solid wastes for more than a few hours or days without unacceptable problems related to space, safety (especially fire), sanitation, odor, manning, and damage control. Section 324 of the National Defense Authorization Act for Fiscal Year 1997 allows the Navy to discharge certain processed solid wastes, but no plastics can be discharged anywhere in the world. Furthermore, the Navy is expected to eventually fully comply with Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), which prohibits solid waste discharges in “special areas” designated by the International Maritime Organization (e.g., the Mediterranean Sea and Persian Gulf). Shipboard thermal destruction of solid wastes offers the most efficient and complete strategy for complying with overboard discharge restrictions and significantly reducing shore offload and disposal costs.

This technology is cooperatively funded by the Navy and SERDP (see p. B-75 and B-90).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Define shipboard performance and interface specifications for an advanced incinerator to replace the Navy’s existing “MILSPEC” incinerator on large ships, issue an RFP, and award a procurement contract
- Initiate planning for a thermal destruction laboratory facility in which to test solid waste thermal destruction systems and monitor air emissions

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Solid Waste – Submarine Plastic Waste

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective is to develop mission-compatible plastics waste processing/packaging techniques and suitable shipboard storage locations for every class of submarines (SSN-688, SSBN-726, SSN-21, and SSN-774) that allow deployment-length holding of all plastics waste. Submarines will not be allowed to discharge any plastics waste overboard anywhere in the world as of 31 Dec 2008 in accordance with the Act to Prevent Pollution from Ships as amended by the Marine Plastics Research and Control Act and Section 1003 of the National Defense Authorization Act for Fiscal Year 1994. Solutions to long-term onboard holding of plastics waste, especially food-contaminated waste, must meet critical submarine requirements related to the enclosed atmosphere, submerged operation, damage control, health and safety, limited space, and quality of life.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Install prototype equipment and space modifications on board two SSN-688 Class submarines through Temporary Alterations (TEMPALTs) and conduct at-sea test and evaluation
- Investigate potential storage techniques and locations for SSBN-726 Class submarines

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Thermal Actively Controlled Sludge Treatment

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The DoD currently makes wide use of oil/water separators (OWS) to remove oil from a variety of aqueous waste streams prior to discharge. On-site or shipboard methods to treat or reduce the volume of accumulated sludges generated by these OWSs are required to eliminate sludge transportation costs for offsite disposal, to reduce downtime for maintenance, and to increase separator efficiency.

The Naval Air Warfare Center Weapons Division (NAWCWPNS) proposes a highly compact, high performance, two-stage incineration process comprising: (1) primary vortex containment combustion (VCC) process, which also separates and retains particulates; (2) self-propagating, high-temperature synthesis (SHS) thermal processing and encapsulation process for treatment of resultant ash; and (3) actively controlled and monitored after-burner (AB) process for emissions reduction. The process can be automated and integrated into a comprehensive, continuously operated, oily water treatment system. The technical approach builds on the Compact, Closed-Loop Controlled Waste Incinerator for Backwater successfully developed in a previous SERDP project. It consists of six development phases: (1) Fundamental laboratory-scale studies (injection, swirl design, flame stability, laser diagnostics, modeling, ash treatment) on surrogate sludge waste mixtures; (2) VCC and AB integration schemes; (3) Conceptual design; (4) Scale-up and testing of practical embodiments under full-scale conditions; (5) Integration of monitoring and automatic active control schemes; and (6) Testing requirements definition for future transition to a dem/val program. The research will be conducted in conjunction with Energy and Environmental Research (EER) Corporation and several universities. NFESC, CERL and AFRL will also provide in-kind support. Collaboration with TeamTec, Norway, a commercial marine incinerator manufacturer, may be extended from the previous SERDP project.

This technology is cooperatively funded by SERDP and the Navy (see p. B-75 and B-88).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete non-reacting and laboratory combustion tests
- Complete VCC Test Unit tests
- Complete AB tests
- Establish control authority with VCC swirl
- Establish effect of transient and variable VCC operation conditions
- Select simplified controller concept
- Complete evaluation of VCC / AB Test Unit
- Complete Test Unit shakedown tests with diesel and water
- Complete VCC LC tests with realistic sludge injectors and diesel fuel
- Complete evaluation of optimized Test Unit
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

COMPLIANCE:

OTHER

PROJECT SUMMARY

TITLE: Contamination of Plastic Media

BUDGET ACTIVITY:

PROGRAM ELEMENT: 0605854F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Current use of plastic bead media for paint removal on different substrates requires separate equipment due to contamination metal particles and paint residue. Project will identify methods to remove contamination in the media reclaiming process to allow use of the same media for multiple substrates. Results will determine if contamination can be eliminated or validate that it poses no risk for corrosion problems.

ANNUAL PERFORMANCE OBJECTIVES FOR FY 99:

- Field survey to evaluate extent of contamination of plastic media and any corrosion on processed parts

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: ARO Chemical/Hazardous Materials Disposal

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: This project will develop a conceptual design for a self-contained chemical munitions remediation system (CMRS) which will receive, contain, access, monitor, and treat recovered non-explosive chemical weapon munitions (CWM) on site. It will compliment stockpile and non-stockpile demilitarization missions. The approach involves:

- Assessment of agents and CWMs.
- Identification of technologies to remediate chemical warfare agents and hazardous materials.
- Development of concepts for integration into a mobile system.

This project is not focused specifically on an Army environmental requirement, but addresses the CWM aspect of Army requirements.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Commenced survey of chemical agents and weapons
- Initiated preliminary conceptual design process for a self-contained CMRS
- Established list of vendors and technologies

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: Commercialization of Technology to Lower Defense Costs Initiative

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: The objective of this project is to lower U.S. Defense procurement costs by: leveraging manufacturing technologies already under development and sharing costs with industry. The approach involves:

- Identify documented critical Defense needs to reduce costs associated with manufacturing, sustainment and environmental needs.
- Identify environmentally acceptable technologies available for commercialization to meet these needs.
- Identify similar commercial opportunities to ensure costs are shared with industry.
- Develop business plan to optimize success of appropriate technologies.
- Demonstrate selected technologies to DoD and industry to insure highest probability of success.
- Facilitate commercialization transactions of environmentally acceptable manufacturing and sustainment technologies. (identify outside financing, commercialization plans and deal structuring).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Increase by 25 percent the number of technologies sourced and evaluated for commercialization
- Increase by 25 percent the number of Federal laboratory technologies to be matched for military and demand side (commercial sector) requirements
- Identify and increase by 50 percent the number of DoD SBIR companies who may be eligible for program participation

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Electronic Equipment Demanufacturing for Reuse and Recycling

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: The objective of this project is to: minimize amount of electronic equipment going to landfills; reduce the amount of hazardous waste generated; reuse/recycle electronic equipment; improve life-cycle management via design and acquisition reform; and proper management of electronic equipment requiring demilitarization. The approach involves:

- Integrated Product Team guidance.
- Identify Stakeholders from government, academia, and industry.
- Conduct needs analysis and identify technology gaps.
- Evaluate potential technologies.
- Dem/Val demanufacturing processes.
- Transfer technologies.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Baseline current DoD and industry electronics demanufacturing capabilities
- Identify areas/opportunities for DoD and industry improvement
- Identify methods and technologies to meet the needs
- Disseminate results

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Evaluation of EPA Test Kit (Light Weight Spectrophotometer) Congressional Earmark

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: The Army has a need for field portable technology to assess petroleum contamination. Therefore, this project will evaluate the H.E.L.P Mate 2000, a field portable spectrophotometer for use with the Hanby Test Kit. The combination of these technologies allows for the rapid on-site analysis of petroleum hydrocarbon contamination in environmental matrices. This promising technology potentially could be used to identify and quantify petroleum contamination on military bases, therefore lowering U.S. Defense procurement costs during characterization and cleanup activities. This instrument was evaluated for establishing the concentration of total petroleum hydrocarbons (e.g. gasoline, diesel and other petroleum products) in both fortified and field samples. Bench studies were performed at the Cold Regions Research and Engineering Laboratory, Hanover, NH, and a technology demonstration field study was performed at the Naval Construction Battalion Center, Port Hueneme, CA, an Advance Fuel National Environmental Technology Test Site.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Conduct and document field technology demonstration
- Initiate bench tests

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Improved Incorporation of Health and Safety to Facilitate Accelerated Implementation of Innovative Environmental Technologies

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: This project focused on three tasks: 1) development of a health and safety expert system, TEXPert 2000; 2) development of a program to document health and safety procedures for new cleanup technologies; and 3) development of baseline documentation of Navy ship scrapping activities. The TEXPert 2000 task will focus on worker health and safety issues incorporated into the design of environmental cleanup technologies. The second task will focus on development of a program to provide health and safety documentation to ease deployment of new environmental cleanup technologies. This program will consider health and safety information at the point at which the technology leaves the laboratory for field testing. In conjunction with the TEXPert implementation project, an overall program will eventually be developed to serve DoD technology safety needs from technology inception to commercialization. The goal is to develop a means to produce a set of documents that are stage dependent and easily modified at the next stage. Objectives will be determined, consistent with the needs of the users and the capabilities of the developer. The output will be a stage dependent emergency response data sheet (ERDS) and technology safety data sheet (TSDS) that will allow the development of a nascent training module.

For the Ship Scrapping Task, a broad approach will be used to determine the potential for an economically viable ship scrapping industry in the United States and to describe the necessary means, if any, to establish one. The scrapping of a ship can be an intricate, labor intensive, mix of cutting and hauling compounded by significant environmental and occupational safety issues. Three areas will be addressed: (1) determine the benchmark methods by which a ship is scrapped; (2) propose improvements in work organization and technology use to lower the cost of scrapping; and (3) use economic information to determine if the process can be structured profitably.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Prepare/revise work plan and collect data requirements for ship scrapping
- Develop baseline description and technology survey for ship scrapping
- Develop workforce/environmental safety & health details
- Prepare ship layout information and evaluate MultiScenario capability
- Improve, develop, and test technology transfer methodologies
- Identify projects for testing the incorporation of health and safety into technology transfer
- Implement CAD into TEXPert and TEXPert to SERDP
- Conduct scenario ranking of TEXPert and testing of the rule based model
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Storm Water Technology Test Bed

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: Ship repair, conversion, dismantling, and naval support activities at Puget Sound Naval Shipyard are significant contributors of pollutants to industrial storm water runoff, which is subject to strict state and federal water quality limits. This project establishes a Storm Water Technology Test Bed to identify, test, and verify the performance of technologies, processes, sensors, and management practices to reduce or treat the storm water waste streams.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Needs Assessment Review
- Technology Survey
- Validation Test Protocol
- Validation Test Report
- Cost/Benefit Analysis
- Final Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Western Environmental Technology Office (WETO)

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: This project will provide Army Environmental Compliance and Pollution Prevention technologies that reduce operational costs. It will also develop/demonstrate innovative environmental quality and industrial waste treatment technologies. The approach involves validating innovative technology in field operations and assessing technology for cost effectiveness and environmental responsiveness. WETO is not focused specifically on an Army environmental requirement, but addresses technology transfer aspects for off-the-shelf technology under specific Army requirements.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Implement Environmental Management Information Systems at Corpus Christi Army Depot (CCAD) and Iowa Army Ammunition Plant
- Demonstrate supercritical fluid extraction from dye
- Demonstrate metal removal using neutral process and microfiltration

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

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CONSERVATION:
ECOSYSTEM MANAGEMENT

PROJECT SUMMARY

TITLE: Predicting the Effects of Ecosystem Fragmentation and Restoration Management Models for Animal Populations

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: DoD training and related activities on and adjacent to military lands often contribute to fragmentation and affect species of special concern, including threatened and endangered species. This project proposes to develop species-specific models that predict the responses of mobile animal species in heterogeneous landscapes. Modeling efforts will build on connections between life history characteristics and the responses of mobile animals to habitat fragmentation and restoration. Field research will permit parameterization of models and testing of model predictions, leading to refinement of the conceptual approach. The primary foci are the ponderosa pine forests and riparian habitats on military lands. These two habitat types are widespread throughout the U.S. and currently the subject of great management debate.

This project is a cooperative effort involving Northern Arizona University, Colorado State University, the Ponderosa Pine Ecosystem Restoration Project, the Semi-Arid Land Surface Atmosphere (SALSA) Project, Camp Navajo (U.S. Army and Arizona Army National Guard), and Ft. Huachuca (U.S. Army). There are three areas of investigation being conducted: 1) acquisition of ecological field data on the responses of animals to habitat fragmentation; 2) the mapping of animal habitats in three dimensions and at scales relevant to habitat management; and 3) the linking of empirical ecological data and spatially explicit habitat information in a management-oriented model, the EAM. Habitat mapping will rely on remotely-sensed data and field measurements. Land Remote-Sensing Satellite (LANDSAT) imagery and aerial photography will permit delineation of the spatial extent, shape, and juxtaposition of habitat patches. Important structural attributes will be explored using Synthetic Aperture Radar, aerial photography, and field measurements. Overlay of pertinent data sets in a Geographical Information System environment will allow integration of habitat attributes and identification of floristically and structurally distinct habitat types, as well as the edges that separate different habitat patches. Completed habitat maps will serve as input to the EAM.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Bird and butterfly assemblages at ponderosa pine sites
- Bird and butterfly assemblages at desert riparian sites
- Complete planning for FY99 field research, based on 1998 results
- Complete analysis of 1998 field data
- Hire post-doc or spatial analyst/modeling research assistant
- Generate first predictions of impacts of landscape pattern on abundance patterns for multiple species
- EAM programming to analyze landscape patterns & link to edge response curves
- EAM programming to link remotely-sensed imagery to field data
- Compare EAM predictions with null model predictions
- Continue field research
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: SERDP Ecosystems Management Project

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The SERDP Ecosystems Management Project (SEMP) was established as an outgrowth of the 1997 SERDP Management Scale Ecological Research Workshop during which it was determined that the DoD should establish a long-term ecological monitoring program at a military base with possible expansion to some other bases in the future. The overall program objective of SEMP is three-fold. First, SEMP directs and selects DoD relevant, ecosystem management research initiatives. Secondly, it manages a long-term ecological monitoring system(s) to support these research efforts while also fulfilling some of the host installations monitoring requirements. Finally, SEMP facilitates the integration of results and findings of research into DoD ecosystem management practices. The SEMP is managed by a separate Program Manager with the assistance of a Technical Advisory Committee (TAC).

Under the Ecosystem Characterization and Monitoring Initiative portion of the program, a team works with the host installation to gather, assess and document historic and current ecological data sources and monitoring efforts. In addition, this team is responsible for long term ecological monitoring. Data from the characterization effort, the monitoring efforts and the research teams all flows into the common data repository, shared by all research teams and the installation managers. Selected research teams work in a collaborative context -- sharing field sites and approaches, entering data into a common repository, reviewing each other's findings, and contributing to common technology transfer mechanisms.

Three projects under SEMP will address the problems on indicators of ecosystem health. First, by Oak Ridge National Laboratory, will look at "Indicators of Ecological Change." The second, led by the University of Florida and Purdue University, will be on the "Determination of Indicators of Ecological Change." The third, led by U.S. Army's CERL, will be "Developing Ecological Indicator Guilds for Land management Research." Site selection will be such as to not duplicate but to enhance the overall understanding of the ecological changes occurring at Fort Benning.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- FY99 proposers initiate field study
- Solicitation & Rev of FY00 SON - Draft FY00 Program Complete
- TAC Activity - Hold session of TAC for review of project plans
- Complete monitoring status report for Ft. Benning
- Data repository design & access protocol
- Plan and Implement SEMP Website
- Selection test indicators and Test Systems Organisms (TSO)
- Develop plan for new monitoring activities at study site
- MOU completed for facilitating work at study site
- Selection of study sites and plots
- Acquisition & fielding of new monitoring equip/stations
- RPA - Determination of Indicators of Ecological Change
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** GIS/Data Management/Modeling**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** Yes.

DESCRIPTION: Weather data and information on the geography and hydrologic performance of the Shipyard's storm water sub-basins is required to develop recommendations for implementing the results of the Puget Sound Naval Shipyard Storm Water Test Bed Project. Additionally, the Shipyard has a need to assess the impact of its NPDES and storm water discharges to receiving waters as a part of a larger initiative to develop a cost-effective, long-range integrated marine environmental compliance program that employs an integrated "multimedia" and "watershed" approach as advocated by EPA. This project develops the geographic information systems, data management systems, and environmental modeling required to support these objectives.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- GIS Data System
- Relational Database
- Hydrodynamic Model

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

CONSERVATION:
IMPACTS ON MILITARY LANDS

PROJECT SUMMARY

TITLE: Analysis and Assessment of Military and Non-Military Impacts on Biodiversity: A Framework for Environmental Management on DoD Lands Using the Mojave Desert as a Case Study

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This research aims to develop a methodology for regional management of biodiversity and related ecological, stakeholder, cultural, and environmental resource concerns. The project is expanding research and technology developed at Marine Corps Base (MCB) Camp Pendleton to address environmental problems at the regional scale in the western Mojave Desert (and will be coordinated with adjacent Department of Energy land holdings). It is analyzing the impacts of military and non-military stressors on patterns of biodiversity and related environmental resources and is assessing the impacts future land uses are likely to have on patterns of biodiversity.

Consisting of four components or phases, this project involves: 1) the development of a Quality Assurance/Quality Control plan and a peer-reviewed experimental design; 2) the initiation of a spatially-oriented data base management and decision support system; 3) the organization of a military and non-military stakeholder group to identify environmental issues and human valuations of the regional ecosystem both within and outside the military context; and 4) identification of military and non-military stressors. The basic methodology for deriving habitat information through vegetation - terrain correlation is being established.

Interaction with ongoing Legacy Program activities (for their databases) through the U.S. Geological Survey's National Biological Resources Division and other groups is critical to this project. The analysis and assessments phase identifies habitat relationships and assesses the management strategies for the Desert Tortoise and other key species. The habitat and management strategies key species are derived and correlated to associated species. Existing land use activities and other stressors on habitat and biodiversity are being evaluated. The effects of future land use scenarios on stressors and on the likely impacts on biodiversity and related environmental resources are being modeled.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete landscape change analysis
- Model Effects of Land Uses on Biodiversity
- Evaluate Effects of Stressors on Habitat
- Complete Data Base Assimilation
- Develop Alternative Future Land Use Scenarios
- Complete Draft Landscape Change Assessment
- Complete Species/Habitat Assessment
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Development and Demonstration of a Risk Assessment Framework on Military Training and Testing Lands

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Downsizing of military installations has increased demand at remaining installations for airspace, water and land area for military testing and training. Long-term suitability of training and testing areas and compliance with environmental regulations must be maintained. The objective of this effort is to develop a structured, scientifically valid risk assessment framework that can be rapidly and inexpensively applied to assess risks of single, multiple, or cumulative impacts of military training and testing activities on natural resources. This framework will incorporate physical, chemical, and biological stressors (including noise) and their direct and indirect effects, short and long term, on natural resources. The feasibility of linking Incremental Cost Analysis with the risk assessment framework will be examined.

This framework will support a risk-based context which will assist the Department of Defense (DoD) to better conduct training and testing activities while complying with environmental regulations, maintaining training and testing realism, and maintaining stewardship of natural resources.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Prepare journal article on conceptual framework
- Complete initial coordination with demonstration site representatives
- Draft DoD-user version of first framework report to Advisory Group for review
- Develop format for site-specific framework
- Acquire site-specific data for demonstration
- Decide on the feasibility of using LMS as a vehicle for tech transfer
- Complete analysis for site-specific demonstration
- Incorporate review comments into DoD-user framework report
- Submit report of demonstration results
- Submit report on results of evaluation of additional avenues of technology transfer
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Project delayed due to departure of initial PI and site selection for second analysis.

PROJECT SUMMARY

TITLE: Ecological Modeling and Simulation Using Error and Uncertainty Analysis

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Ecological models are often used in conjunction with a geographical information system (GIS). This project has three main objectives: 1) to identify and evaluate methods for quantifying uncertainty in spatial data for ecological models; 2) to incorporate Monte Carlo analysis into a framework for uncertainty and error analysis of spatial data in ecological models; and 3) to test and demonstrate the Monte Carlo framework and tools with a case study.

The general technical approach is to account for the sources and the effect of uncertainty in simulation modeling. The investigation complements the error budget approach and is closely coordinated with SERDP project - Error and Uncertainty Analysis for Ecological Modeling and Simulation. The Monte Carlo framework is designed as general and modular software to maximize the ease with which alternative ecological models can be incorporated. This approach facilitates application to different installations, ecological models, and applications.

This project is cooperatively funded with another SERDP project (see p. C-12).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Parameterize our spatially-structured avian demographic model for black-capped vireo and golden-cheeked warbler at Fort Hood
- Acquire spatial data sets required for case study from Fort Hood
- Identify and implement techniques for handling uncertainty in continuous spatial data.
- Collect data to characterize uncertainty for case study
- Complete case study at Fort Knox
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Emerging and Contemporary Technologies in Remote Sensing for Ecosystem Assessment and Change Detection on Military Reservations

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Federal land managers need accurate and affordable ways to assess the health and availability of their training lands. This research is designed to develop techniques that relate ecological concepts of carrying capacity, vegetation dynamics, critical thresholds, habitat fragmentation, ecosystem response and recovery, and land degradation to the response of remotely sensed spectral indicators, and ultimately, to training and testing upon military installations. The objective is to apply spatial and temporal change detection methods over a range of geographic scales using contemporary and emerging remote sensing technologies and traditional field surveys to identify and monitor land degradation.

Land degradation can be defined in terms of ecological endpoints: a change in plant species composition; a decrease in plant productivity; a reduction in soil quality; accelerated soil erosion; and/or, a change in landscape composition and pattern that affect ecological function. The behavior near or at critical thresholds of one of these five characteristics of land-degradation provide a diagnostic basis for the development of remote sensing-based indicators to estimate ecosystem sustainability. Spectral indicators derived from these endpoints measure the response to training activities on military installations. The approach for this project is essentially a composite of: 1) mapping the installation or select components thereof; 2) correlating the fundamental attributes of disturbance, vegetative cover, and plant succession; 3) analyzing, retrospectively, the ecological history of each installation in relation to land use, and; 4) assessing high resolution systems to identify the sensor attributes necessary to monitor changes in plant species composition along disturbance gradients and plant succession stages.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Fly videography on selected transects
- Draft report on spatial accuracy/uncertainty analysis
- IFSAR overflight/ground data instrumentation
- Acquire contemporary imagery - 3rd Site
- Complete development of Internet Web-sites
- Establish survey points at Twenty Nine Palms (29 Palms)
- Complete field work - Fort Bliss (FB), Camp Williams (CW)
- Acquire data, including RFMSS/Land Management data
- Complete Site Water Balance Model - CW and FB
- Algorithm development for large dataset mosaicing and processing
- Scope spatial accuracy/ uncertainty analysis
- Prepare protocol for data entry into models
- Complete analysis of spectral characteristics of species and species groups
- Complete select vegetation maps - CW and FB
- Complete image data analysis - CW and FB
- GIS data and analysis environment setup
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Error and Uncertainty Analysis for Ecological Modeling and Simulation

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: With the growing importance of simulation modeling in natural and cultural resource assessment and management, the Department of Defense (DoD) recognized the need for a comprehensive framework to analyze uncertainty of simulation results. These results are based on estimates of the true parameters and, consequently, are associated with a specific degree of uncertainty. Error budgets can be used to assess the quality of the overall simulation system. Although progress has been made in the areas of uncertainty analysis and error budgets, there is a need to develop the statistical and computational tools to enable model users to jointly assess and quantify the sources and magnitude of errors. These errors are associated with large-scale DoD simulation models used for resource assessment and management. The objective is to develop the methodology for formulating error budgets for environmental monitoring-modeling systems. This project provides the rationale to account for the effect of different sources of error on the uncertainty of model predictions, and the rationale for efficiently reducing that uncertainty.

The approach is to develop an analytical framework and a user-friendly interactive software package to assess and exert control over the quality of the simulation results. This project applies this methodology to a monitoring-modeling system (i.e., Army Training and Testing Area Carrying Capacity (ATTACC)) employed by the military for assessment and/or management of natural and cultural resources at Fort Hood. The project develops a GIS-based methodology to make spatial and temporal predictions, analyze uncertainty, and build error budgets of soil erosion status based on and applied to military training.

This project is cooperatively funded with another SERDP project (see p. C-10).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Initiate R (climate)
- Initiate Multivariate spatial simulation methods
- Initiate Latin hypercube
- Initiate Taylor-series error propagation methods
- Initiate C (cover management factor/military activities)
- Initiate S (steepness)
- Initiate new methods being developed by UI group for correlated errors
- Initiate K (soil erodibility factor)
- Initiate Surrogate modeling methods
- Initiate L (slope length factor)
- Initiate K (soil erodibility factor)
- Initiate R (Climate)
- Initiate Fourier analysis
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Improved Units of Measure for Training and Testing Area Carrying Capacity Estimation

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project proposes to significantly improve the Army Training and Testing Area Carrying Capacity (ATTACC) methodology as an installation management tool to better predict the environmental consequences of military training activities. The focus of this project is to develop quantitative units of measure (such as erosion and species composition on land) to estimate training and testing land carrying capacity, extend the spatial and temporal scale of the methodology to include individual training areas and changes in training and land condition throughout the year, and validate the improved methodology.

In the existing ATTACC methodology, erosion status is estimated using the Revised Universal Soil Loss Equation (RUSLE). The RUSLE equation was developed for agricultural lands and does not account for complex topography that is typical of military lands. The unit stream power approach for estimating the topographic factor of RUSLE will be used to account for complex topography typical of military lands. This project will extend the current ATTACC methodology to include wind erosion in addition to water erosion. Existing wind erosion models will be evaluated to determine which is the most applicable to military lands based on data requirements and model assumptions. The results from the completed SERDP project - Terrain Modeling and Soil Erosion, are being used to improve estimates of land condition and can be extended to off-site impacts (sedimentation and water quality). ATTACC methodology is being expanded to include plant species composition as a measure of land condition. To incorporate species composition into the ATTACC model, the Ecological Dynamics Simulation (EDYS) model, (i.e., a process-based model that predicts changes in species composition that naturally occur over time and in response to natural disturbances) will be utilized.

A sub-model will be developed for the EDYS model that translates training/testing activities into changes in soil and vegetation processes. Existing DoD impact studies are used to estimate the primary impacts of military activities on soil and vegetation processes. The ATTACC methodology also will be extended to account for climatic variation throughout a year. Components of the ATTACC model will be modified to incorporate time varying climatic factors. Temporal differences in mission impacts on the vegetative cover factor will be estimated from existing DoD impact studies.

This technology is cooperatively funded by SERDP and the Army (see p. C-27).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete unit of measure (water erosion)
- Identify Standard units of measure & conceptual model
- Submit sensitivity analysis report
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

CONSERVATION:
MARINE MAMMALS

PROJECT SUMMARY

TITLE: Acoustic Integration Model (AIM) Development

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This task will further develop an acoustic integration model that will be capable of integrating animal behavior with propagation information in order to provide more realistic and sophisticated estimates of sound exposure for marine mammals. Specific enhancements include the ability to use any Navy standard propagation model and database, to emulate virtually any sound source, to interface with the best-known databases of marine animal behavior, and to depict graphically the exposure levels and cumulative exposure over time for the modeled animals.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Establish Living Marine Resources Information System (LMRIS) database interface requirements

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Acoustic Recording Tag for Marine Mammals**BUDGET ACTIVITY:** 2**PROGRAM ELEMENT:** 0602121N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: This task will develop a recoverable, miniature acoustic recording tag that will be attached to whales and used to directly measure both acoustic stimuli and behavioral response from individual subjects over time periods of one to seven days. These data will be used to clarify how the sounds of military operations at sea affect endangered or protected marine wildlife. Three prototypes will be fabricated, attached to whales and evaluated in conjunction with an existing field program. The results will be analyzed with particular attention to the interactions between attachment methods, housing shape, sensor positioning and flow noise. The recording tag design and characteristics that exhibit the best results will be used to fabricate ten tags for further evaluation. The recording tag technology will be transitioned to an industrial collaborative partner for commercialization.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop initial tag design
- Fabricate an operational bench-top recording tag
- Commence development of command and offload software

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Assessment and Mitigation of Fleet Sonar Operations on Protected Living Marine Resources

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This task will demonstrate a means for the Navy to accurately assess and mitigate the impact of its operations on Living Marine Resources (LMR). This task will develop and demonstrate a prototype comprehensive Living Marine Resources Information System (LMRIS) database. Data from various existing databases and references will be used as source information to the LMRIS. A platform-independent graphical user interface, accessible through any web browser on any type of computer platform will be developed that will provide Navy operational planners a geographic visualization of LMR occurrence and restricted oceanic areas.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete the LMRIS for tracking and prediction of LMR occurrences

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Assessment Tool Development for Marine Mammal Critical Habitats

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This task will develop a mapping system to visualize the distribution and movement of marine mammals by time of year and location so that animal movement and distribution can be easily compared to bathymetry and a variety of oceanographic features. The mapping system will be integrated with the Global Information System for the Distribution of Marine Mammals that is being developed by the National Marine Mammal Laboratory (NMML). The mapping system will provide the Navy with the capability to rapidly assess the potential impact of planned operations on marine wildlife so that operations can be modified accordingly.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Establish distribution and movement visualization model
- Integrate animal-borne data into model

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Hazardous and Other Ship Wastes – Marine Mammal Compliance Tools

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective is to develop planning and monitoring tools to minimize the frequency and severity of Navy interactions with legally protected marine animals. Many species of marine animals are protected under the Endangered Species Act (ESA) and/or Marine Mammal Protection Act (MMPA), including whales, dolphins, sea turtles, and sea lions. Regulatory and court interpretations of ESA and MMPA prohibit a wide range of actions, intentional or otherwise, that might affect the health or behavior of a protected marine animal or that might affect its habitat. Navy ships and submarines routinely operate and train in areas where protected marine animals live, breed, or pass through. Regulations promulgated or proposed pursuant to ESA and MMPA have restricted vessel (and aircraft) movements near protected marine animals with regard to distance, approach angle, and speed. Issues related to marine animals (especially whales) and other protected marine animals (especially sea turtles) have interrupted, delayed, or otherwise required costly mitigation strategies for shock trials, routine surface and submerged operations, training exercises (including multi-national exercises), live and inert ordnance drops, underwater sound generation (e.g., active sonar, ship radiated noise measurements), and port ingress/egress. As required by the National Environmental Policy Act (NEPA), the Navy has had to prepare Environmental Impact Statements (EISs) and Environmental Assessments (EAs) specifically for actions that might affect protected marine animals and has had to formally consult with, and obtain permits from, the National Marine Fisheries Service (NMFS). With regard to whales, in particular, protected marine animals has become a significant public relations issue that has invited increased public and regulatory scrutiny.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Continue low-frequency underwater acoustic monitoring for baleen whales in the northeast Pacific Ocean
- Continue to refine and populate the Living Marine Resources Information System (LMRIS) database and information system
- Continue to investigate acoustic fields from sonar projectors and impulsive sources in shallow/littoral waters
- Conduct temporary threshold shift (TTS) experiments with bottle-nose dolphins and beluga whales to correlate with underwater explosion criteria
- Conduct controlled and instrumented in-water testing with post-mortem marine mammal specimens to characterize physical damage attributable to underwater blasts

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Information and Technology Tools for Assessment and Prediction of the Potential Effects of Military Noise on Marine Mammals

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: As concern increases over the effects of man made sound in the oceans [e.g. low frequency active (LFA) sonar and shiplock] on marine mammals, there is limited information. Actual sound frequency-intensity combinations are suspected of causing damage to the hearing of marine mammals. The objective of this project is to provide information that can guide the assessment and prediction of military noise effects on marine mammals.

The approach of this project consists of three tasks: (1) otopathological analyses of marine mammal ears; (2) otopathological analyses of baleen whale ears, the results of which will motivate development of a biomimetic model of baleen whale auditory responsiveness to DoD sound types; and (3) using sensitivity predictions and statistical sampling models and acoustical classification algorithms, to automate the U.S. Navy's Integrated Undersea Surveillance System (IUSS) for mapping the distribution of whales in the Southern California region.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Beamform algorithm survey
- Alpha test automated call detect & identify
- Alpha test call detection algorithms
- Automated Species Identification benchmark report
- Process sound samples through Ear Model
- Submit Model for Peer Review (journal publication)
- CT/MRI analyses
- Histological analyses for FY99
- Refine Ear Model
- Alpha test Beamforming software Version 1
- Select and Acquire DoD sound samples
- Develop & Test 3D algorithms for integrating CT/MRI
- Test and evaluate Beamforming software Version 2
- Integrate micro-CT with Histologic sections for 3D comparisons
- Remote Comms Field test
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Prediction of Acoustic Safety Criteria for Marine Mammals

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This task will demonstrate safety criteria established for marine mammals on the impact of environmental sound from Navy acoustic activities. Specific numbers will be established for essential auditory values such as temporary threshold shifts (TTS) so that the Navy will know whether the perceptions of noise impacts on marine mammals are accurate and provide solid scientific information so that mitigation required for military advanced development, training and testing will be what is actually required and no more.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete Testing of S2 sounds and effects on marine mammals and TTS levels for broad band high and low frequencies

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Marine Mammals

BUDGET ACTIVITY: 1

PROGRAM ELEMENT: 0601153N

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: This program is to determine the effects of manmade sound, especially Navy sounds of interest (sonars, explosives, ship noise) on the marine environment, with emphasis on marine mammals due to their known reliance on sensitive hearing. The goal is to ensure that the Navy is in full compliance with relevant environmental laws while maintaining full operational capabilities at sea.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Publication in peer reviewed literature to establish Navy proactive leadership and discovery in the S&T area

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

CONSERVATION:

REHABILITATION/MITIGATION OF MILITARY LANDS

PROJECT SUMMARY

TITLE: Diagnostic Tools and Reclamation Technologies for Mitigation Impacts of DoD/DOE Activities in Arid Areas

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project is designed to overcome current gaps in diagnostic capabilities needed to distinguish between various degrees of sustainable and non-sustainable impacts due to military training and testing or earth-disturbing activities in desert ecosystems. Additionally, the project aims to develop and evaluate new and cost-effective techniques for rehabilitation and restoration of such disturbed habitats. The technologies being evaluated and tested are divided into two principal areas: diagnostics and restoration techniques. For diagnostic techniques, new rapid detection methods will be developed using hand-held digital cameras and Hi-8 camcorders to record selected ground data such as panoramic views with vertical and horizontal scale references to record shrub height and canopy width, regularly-spaced close-ups to document shrub sprouts, percentage of shrubs alive, emergence of seedlings, and morphological demographic data (approximate proportion of shrubs at different ages or sizes). Images shot from helicopter or fixed-wing aircraft along selected or permanently marked flight lines can be evaluated using computer technologies to provide rapid assessment of vegetation such as total number of shrubs and cover present in selected areas. For example, using aerial photography of a scale from 1:2,000 to 1:24,000 it is possible to selectively scan a photograph and process the image data to rapidly calculate shrub density and total shrub cover in less than a minute per plot. Additionally, data are analyzed statistically to show size classes of shrubs, a parameter important for assessing impacts from training exercises and shrub demographics.

The site potential for restoration is determined by such things as plant species present, seed bank, soil moisture, and nutrients. At some sites, a shift in the plant community composition may also occur, with more sensitive species being replaced by plants that are more resistant to training impacts. Recovery may occur naturally and keep pace with the level of disturbance at some sites, depending on the nature and frequency of the disturbance, or it may require selected restoration techniques to recover from adverse training impacts before sustainable restoration is achieved.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Initial evaluation of LIFI for desert species
- Begin evaluation of diagnostic techniques
- Identify site options for restoration and revegetation
- Select sites
- Conduct Reclamation Workshop
- Obtain materials for 1999 revegetation trials
- Evaluate diagnostic software
- Review program plan by TAT
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Erosion Control Techniques**BUDGET ACTIVITY:** 2**PROGRAM ELEMENT:** 0602720A**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: Soil erosion by water along streambanks is a critical problem on many military facilities, especially those where intensive and/or frequent training and testing activities occur. Erosion control technologies used on non-military lands are often unsuitable for Army training areas. Identification, demonstration/validation, or development of streambank protection technologies is needed to reduce soil erosion by water in large watershed areas.

This technology was cooperatively funded by SERDP and the Army (see p. C-27).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop dust control summary and guidance
- Develop intense use site stabilization guidance
- Complete *Alpha* version of Land Rehabilitation Potential Model
- Develop SedSpec 1.0: Biotechnical Erosion Control Techniques
- Develop resilient species selection criteria

ANNUAL PERFORMANCE REVIEW: Met all performance objectives in FY99.

PROJECT SUMMARY

TITLE: Identify Resilient Plant Characteristics and Develop a Wear Resistant Plant Cultivar for Use on Military Training Lands

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Wear-resistant plants are needed to mitigate environmental impacts and improve the use of Department of Defense (DoD) training lands. Knowledge of the relationships between military training and plant injury, regrowth, and wear resistance is limited. Plant and soil data will be combined allowing land users to make knowledgeable choices concerning plant selection and site-rehabilitation procedures to reduce soil erosion. This project intends to use several collections of resilient and other plants to breed new more resilient cultivars. A second objective is to conduct field and greenhouse studies to quantify the degree of compaction that occurs during training and relate soil condition to root injury in plants with known resilience.

The technical approach for this project begins with the identification and development of training-resilient plant cultivars. Field and greenhouse studies will be conducted to quantify the degree of soil compaction that occurs during training, relating this soil condition to root injury in plants with known resilience. The greenhouse study is on soil compaction and plant root growth. Three species are being studied (Reliant hard fescue, Blackwell switchgrass, and western wheatgrass) and three compaction levels in six soils. The field study is evaluating a naturalized cultivar ('Vavilov' Siberian wheatgrass, *Agropyron fragile*) and two native cultivars (Goldar bluebunch wheatgrass, *Pseudoroegneria spicata* and 'Secar' Snake River wheatgrass, *Elymus wawawaiensis*) which were seeded in mixtures and in several different row-space combinations to determine if rapidly establishing naturalized and native species can be established together.

This technology is cooperatively funded by SERDP and the Army (see p. C-26).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Continue evaluating plant materials at Yakima Training Center WA, Fort Carson CO, and USDA-ARS, Logan, UT
- Prepare report on spreadability of new germplasm
- Prepare journal article on growth potential of native and introduced plants on semi-arid lands
- Evaluate 20-year-old seedings
- Prepare journal article on root injury due to training
- Evaluate performance of cultivars and species in mixed seedings
- Begin greenhouse studies on soil compaction and plant root growth
- Convene Independent Review Panel at Yakima Training Center
- Make second-cycle selections and collect data from evaluation trials
- Determine spreadability of new germplasm at YTC
- Apply controlled tank traffic on plots to provide realistic selection pressure
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Land Capability/Characterization**BUDGET ACTIVITY:** 2**PROGRAM ELEMENT:** 0602720A**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: Past and current military land practices have resulted in damage and degradation of the resources necessary to ensure optimal training conditions. Specific high-impact practices include tactical vehicle and rotor-aircraft use, which can cause loss of native vegetation and soil microorganisms resulting in soil destabilization. Presently, conditions exist on some installations that promote increased proliferation of undesirable scavenger and predator species, potentially impacting adjacent landowners, endangered species, and overall ecosystem balance. Extensive resources are being invested to correct these problems such as controlling nuisance wildlife and replacing exotic species, which are undesirable. Protocols are needed to determine the extent to which given parcels of land, particularly on FORSCOM and TRADOC installations, are suitable and contain the carrying capacity for sustaining high-impact activities. Efficient methods to identify, understand, and monitor keystone and indicator species, and the relationship between these species and the ecosystem are needed to evaluate impacts and ecosystem changes. Also, methods need to be established to reduce nuisance species that threaten endangered species, destroy property, cause environmental degradation, and transmit disease.

This technology was cooperatively funded by SERDP and the Army (see p. C-13).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- By FY02, sediment/wind erosion impacts completed
- By FY04, analysis and mitigation completed

ANNUAL PERFORMANCE REVIEW: Met all performance objectives FY99.

PROJECT SUMMARY

TITLE: Computer-Based Land Management System (LMS)

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: The objectives of this project are to build a capability that serves multiple application domains related to land/water resource management and analysis; develop greater interoperability of products across DoD technology programs; reduce users' costs for delivery of computer-based technology products; and create a network of testing/demo facilities with field instrumentation, data repositories, site points of contact, collaboration across multiple research efforts, and planning/review processes. Installation partners will identify and prioritize land management challenges that require improved technology integration. Installation partners include Ft. Hood, TX, Marine Corps Air Ground Combat Center (MCAGCC), Twentynine Palms and Ft. Irwin, CA, and Ft. Benning, GA. Models and protocols for wind-erosion, vegetation, weather and soil moisture addresses Army requirements for improving Army land management.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Verify wind-erosion modeling options for integration into the Army's land capability model
- Test computer-based modules to assist learning
- Demo/revise vegetation mapping protocols through multi-tiered vegetation mapping
- Install/test real-time weather/soil moisture data records and integrate with training usage plans and training distribution model
- Hold Army and DoD workshops
- Develop/test protocol for field comparisons of watershed models

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

CONSERVATION:

THREATENED AND ENDANGERED SPECIES

PROJECT SUMMARY**TITLE:** Advanced Biotelemetry for Resource Management**BUDGET ACTIVITY:** 3**PROGRAM ELEMENT:** 0603716D**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: This project focused on the development and testing of 1-2 gram, radar-activated, radio tags for tracking and monitoring extremely small birds and other species. The technical objective of the project effort is to develop and evaluate the potential of harmonic radar to track regional and local movements of small threatened, endangered, and sensitive species (such as birds and butterflies) for risk assessment and ecosystem management. The primary benefits of this project will be cost savings for DoD resource managers, enhanced research and management capabilities, and new technologies for a variety of users. Cost savings to the military will accrue in several ways. First, application of new methods and techniques will allow more effective study of special status species. Second, application of these methods and techniques will require fewer personnel than in the past. Third, fewer persons in the field for shorter periods will reduce interference with military activities. The near real-time integration of this data collection capability with both Geographic Information Systems (GIS) natural resource information and military land use activities will provide managers with a unique ability to support readiness on installations while managing for conservation and biodiversity. The use of harmonic radar tracking provides DoD and other land managers with sophisticated refinement of field ornithology at a time when there is tremendous pressure to manage and protect many small avian species.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Static field testing of radar activated VHF tags at different distances
- Complete radar activated VHF tag printed circuit board layout
- Have prototypes of the printed circuit board layout made, and take delivery
- Testing and completion of Prototype Bench tag design
- Identify suitable radar system
- Optimize radar system
- Document field results and provide to SERDP as a GO/NO-go Determination
- If GO, begin developing algorithms for location processing using radar and VHF return data
- Identify suitable bird species for demonstration and assess attachment techniques
- Develop Technology Transfer Plan in accordance with SERDP guidelines
- Establish the necessary radar modifications for crossband operation
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Assessment of Training Noise Impacts on the Red-Cockaded Woodpecker

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project is addressing the impact of training noises on the endangered red-cockaded woodpecker (RCW), and developing cost-effective techniques to evaluate and monitor effects of military noise on animal species. These techniques include the capability to characterize noise stimuli, document physiological and behavioral responses, and determine resulting population effects due to military noise.

The approach assumes that proximate effects can be linked to individual fitness, which in turn can be linked to population effects. The proximate response is measured by observing the number of flushing from the nest cavity and feeding behavior (non-nesting). Field studies of the in-situ response of the animal to the measured noise events will be used to determine dose-response relationships. Individual fitness measurements will include the number of young fledged per nest, adult turnover, group size, and mating success. These demographic parameters will be correlated with measured noise levels. Another noise assessment being considered involves correlating historic demographic data with estimated noise levels, using available training noise models. The empirical data from these efforts will be integrated into leveraged RCW population models to assess noise impacts at the population level. Four noise types are considered: artillery noise, small arms noise, helicopter noise, and maneuver noise. (i.e., combination of artillery, small arms, and helicopters.)

This technology was cooperatively funded by SERDP and the Army (see p. C-33).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Completed second year field data acquisition
- RCW surrogate AEP audiogram available
- Second season data analyzed
- Complete preparations for FY99 field season
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Baseline Inventories and Research**BUDGET ACTIVITY:** 2**PROGRAM ELEMENT:** 0602720A**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: In compliance with the Endangered Species Act, the Army has identified 248 listed species on its lands and the U.S. Fish and Wildlife Service may add additional species to the list of Threatened and Endangered Species (TES). The loss of TES is most often due to loss or disturbance of critical habitat. Thresholds for Army unique activities need to be researched/established for each TES resource area (i.e., birds, bats, mammals, reptiles, fishes, snails, insects, crustaceans, amphibians, and clams). The Army needs complete TES baseline inventories. Minimal acceptance surveys are needed to establish population numbers, monitoring criteria, and incidental take. A limitation to TES surveying and monitoring tasks is the risk to human health and safety from the exposure to unexploded ordnance (UXO) detonation for surveys conducted on active ranges. To avoid human risk, various remote sensing options are needed to complete these inventorying tasks. Once baseline inventories have been established, methods will be needed to determine realistic population goals in order to prevent unnecessary impacts from ESA to mission activities. The Army requires their installations to establish individual TES population goals for their installation. Objective criteria and modeling capabilities, including military mission and carrying capacity, are needed to justify population goals in the context of the Army-unique mission.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Review of survey methods implemented on Army lands
- Develop prototype frequency-agile radio telemetry receiver for use on threatened and endangered species
- Evaluate data analysis algorithms

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: Impact Protocols of Military Operations on Threatened and Endangered Species

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Endangered Species Act has stopped military training exercises due to the growing impacts on threatened and endangered species (TES) located on Army installations. Impacts on TES can include elevated noise levels and air, water, and soil contamination from training with obscurants, riot control agents, and explosive impact demolition materials. There is an urgent need to develop three management protocols that address (1) maneuver training, (2) smoke and obscurants, and (3) noise (vehicle and blast) impacts on TES habitat disturbance. Without these protocols, the U.S. Fish & Wildlife Service is forced to hold the Army to the most stringent standards to protect TES. Maneuver training avoidance protocols need to consider prevention of fragmentation effects on TES habitats. Training corridors are currently being used to avoid the identified TES members, but this affects training effectiveness. The primary TES focus is on birds, bats, and the Desert Tortoise. Secondary focus should be on mammals, reptiles, fishes, snails, insects, crustaceans, amphibians, and clams. Tertiary focus should be on avoidance or cultivation protocols for various TES plant species.

This technology was cooperatively funded by SERDP and the Army (see p. C-31).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop a process to assess the impacts of maneuver training on T&ES and reduce restrictions on training while protecting these species
- Develop smoke risk assessment impact model
- Assess training noise impacts on red-cockaded woodpecker

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: Threatened, Endangered, and Sensitive Resources

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Growing numbers of threatened, endangered, and sensitive species (TES) found on military lands increasingly result in mission constraints and impediments to land acquisition, potentially leading to reduced defense readiness; lengthy and costly litigation; and criminal and civil penalties. Major objectives of this research were to continue efforts to manage TES habitats and to mitigate the effects of military-unique impacts. Specific technical objectives were to: (1) develop regional guidelines for TES habitat/community evaluation and management; (2) evaluate approaches, methodologies, and techniques to enhance conservation of TES plant population; and (3) develop conceptual models of impacts of smokes, obscurants, and chemical stimulants on TES and make predictive assessments of effects of selected material and species.

These efforts contribute substantively to a comprehensive, systematic, and integrated approach to TES management on military lands. Through this effort, the military has developed and demonstrated scientific and technical leadership in the management of TES, thus allowing for better integrating TES considerations with military activities while avoiding mission impacts. On-going interagency coordination will yield benefits at the national, regional, and local levels. Improved prediction of smokes and obscurants has helped the communities provide a realistic assessment of risks to threatened and endangered species.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Final report of results of avian nestling & immunotoxicity tests with fog oil
- Complete draft report of final risk assessment for RCW and fog oil
- Final risk assessment report for RCW and fog
- Complete field tests
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

CONSERVATION:

OTHER

PROJECT SUMMARY

TITLE: Direct Detection of Archeological Sites Using Remote Sensing

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this one-year pilot study is to improve the identification and assessment of prehistoric, historic, and traditional cultural properties for sites on Department of Defense (DoD) and Department of Energy (DOE) lands. This study will partially address that need by identifying the type of archaeological materials that can be detected remotely. The focus of the research is to determine if ceramic and obsidian artifacts are theoretically and practically detectable given the characteristics of the measuring instruments and spectral contrasts between targets and typical backgrounds.

The technical approach involves measuring the spectra of obsidian and ceramic artifacts under field and laboratory conditions. The data will then be used to support a "detection limits" model to predict what kinds and amounts of materials are theoretically detectable with any given remote sensing device. Field spectra of representative background and target materials from study sites at China Lake Naval Air Weapons Station (CLNAWS) and Los Alamos National Laboratory (LANL) will be collected using two thermal infrared (TIR) and one visible/near infrared (VNIR) instruments.

Through the use of a reference library of actual spectra of target and background materials collected from the two study sites and given the instrumental limits of scanner systems, the detection limits of various target materials will be established. The detection limits approach will also be used to identify which wavelengths are needed for discrimination of obsidian and ceramics from background and other foreground materials.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete field work at CLNAWS
- Complete detection limits model
- Complete fieldwork at LANL
- Submit final report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Dynamic Modeling of Military Training Impacts and Archaeological Site Distributions in Evolving Landscapes

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This one-year "proof-of-principle" study addresses the ability to effectively model and predict the distribution of archaeological (including prehistoric, historic, and traditional cultural property) resources on military and Department of Energy (DOE) lands and ranges, and address the potential or probability of unique impacts that adversely affect those resources. It is aimed at (1) demonstrating the effectiveness of a 3-D computer simulation approach to predictive archaeological modeling and resource risk assessment, and (2) demonstrating that the approach is transferable to other installations or facilities where these resources are at risk from three-dimensional (subsurface) impacts.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Model output and comparison of Geoarchaeological Data for Wildcat Creek
- Comparison of 2D and 3D Approaches to Predictive Archaeological Modeling
- Assessment of Transition Potential of Approach
- Calibration of CHILDR Model with Fort Riley Paleoenvironmental Data
- Final Technical Report on Wildcat Creek Study, Fort Riley, KS
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Project delayed 10 months due to financial delays.

PROJECT SUMMARY

TITLE: Hawaii Small Business Center

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: This Congressionally mandated project is a continuation of an effort begun in FY93. The project has technology policy goals favoring activities that meet dual-use and employment-creating criteria. The former refers to commercializing products that are used by Armed Services personnel as well as the civilian population. The latter is offered as a contribution to U.S. economic revitalization. The approach involves private-public partnerships to carry out activities leading to the commercialization of these products. These include but are not limited to pharmaceuticals, industrial products and food products derived from the agricultural resources of transitioning sugar plantations in Hawaii. Advisory personnel from federal agencies (primarily the DoD and Agriculture) and state agencies participate at the work group and oversight committee levels. This project is not focused specifically on an Army environmental requirement, but will be leveraged to the greatest extent possible.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Transfer funding to USDA
- Approve award of funding to the two active sugar operations to support diversified agriculture on their land
- Approve award of funding for the Honokahau Ditch repair on West Maui
- Monitor the completion of the algae project with Tripler Army Hospital
- Develop an exit strategy for the program

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

APPENDIX D

POLLUTION PREVENTION PROJECT SUMMARIES

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POLLUTION PREVENTION:

GREEN MUNITIONS AND ENERGETICS

PROJECT SUMMARY

TITLE: 2.75" Rocket Motor Manufacturing Waste Minimization

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: All Department of Defense (DoD) military Services use a 2.75" rocket system for a variety of missions. Procurements of more than 875,000 rockets are planned throughout the Future Year Defense Plan. However, the double-base propellant does not meet Insensitive Munitions requirements. A current solution is the use of an extrudable composite propellant that consists of an elastomeric binder filled with energetic solids as oxidizers. The batch manufacturing processes that are planned for this new propellant will not reduce the waste over current production methods. Another shortcoming is the need to use significant quantities of organic solvents to aid the propellant mixing. The purpose of this project is to demonstrate a robust twin screw continuous process for the manufacture of 2.75" extruded composite propellant grains.

The proposed continuous twin screw extrusion technology converts raw materials into a final grain geometry within a single facility. The process will reduce pollution and propellant processing cost while maintaining or improving quality, performance, and reliability of the system. Using the existing continuous process development facility and expertise at the Naval Surface Warfare Center, Indian Head Division, the performance of the twin screw processed 2.75" rocket will be demonstrated and validated. The continuous twin screw technology will be evaluated for three attributes relative to the conventional batch process: acceptable product performance, minimum environmental impact, and low manufacturing cost. The merits of the continuous process will be assessed by 1) characterizing and comparing the product manufactured by each process, 2) determining the reduction of waste generated and volatile organic compounds (VOCs) emitted from the twin screw process versus the batch process, and 3) validating the cost reduction of the new technology.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Make water jet cutting system operational

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Demonstration and Qualification of Small Caliber Combat Ammunition Manufactured with Lead-Free Projectiles

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The firing of lead-bearing, small-caliber ammunition for military training, law enforcement, and sport is often a source of environmental pollution. On many Department of Defense (DoD) shooting ranges, soil and water contaminated by lead from small arms ranges are ingested by wildlife and are also a threat to human health and safety. Even indoor DoD ranges can pose a health threat when personnel fire weapons containing lead-bearing ammunition in an enclosed space.

DoD is currently looking into avenues for addressing the current health and environmental threats from these activities and reducing future contamination. A significant reduction in environmental pollution can be achieved through the development of ammunition projectiles composed of non-hazardous, economically recyclable materials. Ammunition formed with substances, such as tungsten and tin, may provide the solution to this problem. The objective of this project is to provide the DoD with small-caliber combat ammunition manufactured with lead-free projectiles.

This project tests the feasibility of utilizing nontoxic materials, such as tungsten and tin, to replace the lead projectile cores currently used in 5.56-mm ammunition. Continued efforts will produce a 5.56-mm lead-free projectile configuration and qualify the new cartridge as a replacement for the current M855 Service round. Additional efforts will demonstrate nontoxic projectile alternatives for 7.62-mm ammunition and replace the lead-base filler in the .50-caliber M33 ball round. The development and evaluation of this nontoxic ammunition will examine all aspects of bullet design and materials selection.

This program is a part of the “Green Bullet” initiative and complements other ongoing efforts.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- 7.62mm - Develop alternative material (based on 5.56 mm)
- 7.62mm - Receive Funding
- 7.62mm - Conduct Market Survey / Commercial Evaluation
- Tracer - Obtain Test Samples
- 7.62mm - Prepare Test Plan
- Tracer - Conduct Testing
- Tracer - Prepare Test Evaluation Report
- Tracer - Implement Recommendations / Engineering Change Proposal (ECP)

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Eliminate Heavy Metals from Small Caliber Ammunition

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The manufacturing, testing, use, and disposal of small caliber ammunition presents many environmental problems. Environmentally objectionable materials include lead and lead-antimony in the projectile slugs, and lead styphanate, antimony sulfide, and barium nitrate in the primer composition. Approximately, 689 million rounds of small arms ammunition are fired annually during training that approximately introduces 20,000 tons of lead into the environment. Another 50,000 tons of lead is released by the commercial sector. Approximately, 2 million pounds of lead-antimony is annually used for projectile cores and 9000 pounds of lead styphanate is used per year in cartridge primer compositions.

The objective of this project is to eliminate the major toxic materials from small caliber ammunition (5.56mm, 7.62mm, 9mm, and 0.50 Cal.) which meets US and NATO performance standards. It will develop composite materials to replace lead-antimony in projectile cores and will investigate metastable interstitial composites (MIC) as alternatives to lead styphanate in cartridge primer compositions. A MIC material is an engineered material consisting of two or more chemical species that are exothermically reactive with each other. A typical MIC composition consists of a metal and a metal-oxidizer, both of which are ultra-fine grain form. The MIC composition proposed for use in ammunition primers is a stoichiometric mixture of aluminum and molybdenum. The reactants of this reaction are non-toxic and environmentally benign.

This program is a part of the “Green Bullet” initiative and complements other ongoing efforts.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete and Summarize leaching studies on unaged materials
- Complete and Summarize leaching studies on aged materials
- Complete and Summarize leaching studies incorporating modified/improved non-lead materials
- Complete initial bio-uptake studies utilizing selected plant species and earthworms
- Conduct Performance Testing of Test Primers in Cartridge Cases
- Test MIC in 7.62mm & Cal .50 Configurations
- Complete Long Term Storage Test of MIC Primers
- Determine Effects of Primer Component Configuration on Ignition Sensitivity
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Elimination of Toxic Materials and Solvents from Solid Propellant Components

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The overall goal of the “Green Missile” program is to eliminate major sources of toxic/hazardous materials used in solid rocket propulsion systems. The objectives are to: 1) develop lead-free extrudable and castable propellant for minimum smoke systems; 2) develop complete and clean, HCl-free, combustion of propellant; 3) develop solvent-less methods for processing energetic oxidizers; and 4) develop thermoplastic elastomer based inhibitors. The technical risk of this research is that the materials developed may not have the necessary propulsion characteristics.

- *Lead Elimination:* Propellants containing ammonium nitrate (AN) with CL-20 or AN with RDX will be developed further to optimize combustion properties. Combinations of CL-20 and ammonium dinitramide (ADN) will be developed, the chemical and physical properties of their different material forms will be characterized, and their formulation and processing will be evaluated.
- *HCl Elimination:* Ultrafine Aluminum (UFAL)/ADN propellant compositions will be evaluation using low-solid content and energetic plasticizers to give highly efficient and clean burning propellants while meeting performance requirements.
- *Clean Oxidizer Processing:* The solventless process set up for preparation of molding powders on the 100 gm scale by coating RDX with dioctyl maleate (DOM) using supercritical carbon dioxide (referred to as CXM) will be modified in order to utilize supercritical propane to coat RDX with polyethylene.
- *TPE Development for Solid Rocket Motor Propellant:* Three different polymeric inhibitor systems will be evaluated as potential replacements for the baseline cellulosic inhibitor. The candidates are polyphosphazenes, POSS polyurethanes, and POSS norbornenes [POSS= poly(oligosilsesquioxane)].

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Demonstrate generation of large comminuted particles
- Determine adhesion characteristics of TPE candidates
- Initiate lead free TPE formulation development
- Burn rate studies and optimization for ADN/CL-20
- Mechanical properties/processing studies for ADN/CL-20
- Complete evaluation/down selection of bismuth formulations for castable formulations
- Formulation modification with clean oxidizers (ADN/CL-20) for castable formulations
- Initiate formulation of affiliated bonding agents
- Select binder composition
- Scale up TPE candidate for further evaluation
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Energetics Manufacture with VOC Emission Reduction

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Propellant manufacture involves mixing ingredients within a solvent solution at elevated temperatures. The purpose of this project is to dramatically reduce volatile organic compound (VOC) emissions and recycle propellant waste by using a closed loop propellant processing system (CLEVER) showing drastic environmental and process improvements. A side-by-side comparison of CLEVER with conventional processes will be implemented to evaluate them for relative environmental impact and propellant performance.

All propellant ingredients are mixed and dissolved in a suitable solvent at slightly elevated temperatures and pressures. In the CLEVER process, the solution is pumped from the mixing vessel to a steam-driven ejector where powder is precipitated by injected steam. A cyclone separator is used to separate the solvent from the propellant/water slurry. The propellant is collected and the water, containing 15 percent residual solvent, is removed. This water/solvent mixture is then sent to a biological waste reducer. The pure solvent fraction is recovered and returned to the process. The CLEVER process has several advantages over conventional mixing operations: (1) the process reduces VOC emissions by 85 percent; (2) propellant waste is eliminated because it can be returned to the process and reprecipitated; (3) the need for grinding is eliminated, reducing solvent emissions and enhancing safety; and (4) the new process is as much as 50 percent less costly to operate. In addition, CLEVER produces high quality propellant for use in the U.S. Navy's new 5-inch gun-propelling charge. Demonstrations will take place at the two active gun propellant manufacturing facilities—the Naval Surface Warfare Center, Indian Head Division, and the Radford Army Ammunition Plant.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Manufacturing Lessons Learned Design Mods
- Conduct Ballistic Testing
- Begin Analysis of Data
- 2nd Batch of Propellant Paste Delivered
- Conduct DOE and Propellant Quality Tests
- Determine/Validate Propellant Granulation
- Manufacture Propellant Grains
- Gather Data for ECAM Final Report
- Quality and Performance Testing

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: High Lethality Affordable Green Energetic Materials

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Demonstrate that the cost of propellants and explosive used in military munitions can be reduced, simultaneous with environmental waste reduction, during manufacture and demilitarization by using green energetic materials and processes.

Green energetic materials are propellants & explosives whose ingredients can be recovered, and recycled or reused at the end of their useful life rather than being burned or detonated during demilitarization.

The green process is use of a continuous twin-screw extruder to mix the ingredients. It can mix the ingredients with little or no solvent and is not so labor intensive as the batch mixer it replaces. Labor intensive batch mixing procedures make extensive use of (volatile organic compound) solvents.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Waste reduction manufacturing process scale-up & validation: load green explosives into Extended Range Guided Munitions warhead bomblets at Lone Star Army Ammunition Plant
- Full-scale performance testing on full scale gun propellant test firing in Navy 5"-62 gun at Dahlgren, Virginia and full diameter rocket propellant test at Thiokol Propulsion in Utah
- Life-cycle cost & environmental estimate: specific production and demilitarization waste comparison between green energetics and energetics intended for use in the Extended Range Guided Munition energetics; specific production and demilitarization cost comparison between green energetics and energetics intended for use in the Extended Range Guided Munition energetics

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Ordnance Binder Materials (Hydrolyzable)

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: To enhance the utility of the WITCO-10-PE-37 Binder using state-of-the-art synthetic techniques for improving its hydrolysis rate and mechanical properties. The end result is as follows: a). a reduction in the quantities of hazardous waste by enabling the environmentally benign hydrolytic demilling of a greater variety of munition types, b). increased worker crew safety from environmental hazards during demilling by the elimination of volatile solvents and c). life-cycle cost savings through environmentally-benign demilling.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Baseline gumstocks synthesis, scale-up, hydrolysis rates and mechanical properties completed
- Modification of polymer compounds and propellant formulation
- Evaluation of modified formulations for physical properties and environmental stability
- Transition of technology for fleet-wide use

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Powder Coating for Small-Arms Bullet Tip Identification

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Small arms ammunition (i.e., ball, tracer, incendiary, armor piercing), projectile tips are painted for identification purposes. This program will demonstrate and validate the use of powder coating technologies for bullet tip identification. This innovative technology eliminates current costly paint processes that emit volatile organic compounds (VOCs) and ozone depleting chemicals (ODCs). The demonstration will also validate environmentally friendly solvents, cleaners, and lubricants needed for charging, loading, cartridge assembly, and packing operations.

Currently, small-caliber ammunition is marked by dipping or spraying the projectile with a low-volatile organic component paint. The surface of the bullet must be free of contamination, thus requiring preparation with a solvent (methyl chloroform or acetone). The spray application process is only 5- to 10-percent efficient, and overspray is captured in a filter hood and vented into the atmosphere, releasing VOCs. In addition, paint passing through the filters and vent stack adheres to the sides of the stack, eventually clogging the vent and creating a hazardous work environment. The dip coating process is sensitive to a number of variables including temperature, humidity, paint viscosity, paint level in the reservoir, and equipment setup.

Unlike liquid paint processes, powder coatings are pure dry paint particles that require no liquid solvents. The coatings can be applied using two different methods: dry spray or fluidized bed. For either method, the projectile tip is heated through one of several heating processes (i.e., induction, conduction, convection, or infrared) to between 250°F and 350°F, and the powder is then applied to the surface. The amount of heating and the time of application are kept to a minimum to avoid auto-ignition of tracer/igniter/incendiary mixes. Because powder coatings remain in their original state until exposed to heat, spillage or overspray can be easily collected and reused. The materials are also recyclable; therefore, the process will not produce a waste stream.

ANNUAL PERFORMANCE OBJECTIVES:

- Continue development of Lake City Army Ammunition Plant Demonstration Plan

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Recycling Propellants in Nonpolluting Supercritical Fluids: Novel Computational Chemistry Models for Predicting Effective Solvents

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Waste solid explosives and gun propellants are destroyed primarily by open pit burning or incineration. Extraction and recycling of the propellant using a non-polluting, inert supercritical fluid (SCF) solvent such as CO₂ has economic and environmental advantages. Although the ingredients in composite (nitramine based) propellants are insoluble in CO₂, solubility is enhanced when trace amounts of simple polar modifiers are added to the SCF solvent. The objective of this project was to determine the optimal physical conditions and chemical makeup of an effective SCF CO₂ solvent with added polar modifier using well-established computational chemistry techniques. The technology developed in this project will have application to nitramine-based explosive and propellant formulations.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Extend model to include solubility predictions for HMX
- Improve model for prediction of nitramine solubility by refining and testing against an additional 2 cosolvents
- Extend model to include solubility predictions for TNT
- Produce table of potential energy parameters for classes of cosolvents and explosives tested experimentally
- Incorporate enhancement of model in existing FORTRAN version of software to predict solubility of energetic components in polar-modified CO₂ solution vs. temp, pressure, concentration & polarity of the modified component
- Locate source of the discrepancy between predicted and experimental solubility data for neat SCF CO₂ as a function of temp and pressure, make any subsequent refinements to model
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Reduce Hazardous Components in Ordnance

BUDGET ACTIVITY: 1 & 2

PROGRAM ELEMENT: 0601102A, 0602105A

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Hazardous ingredients in propellants, explosives and pyrotechnics formulations need to be replaced by non-hazardous ingredients. Munitions containing lead currently causes major problems with test range clean-up and metal manufacturing processes. Elimination or reduction of hazardous components in ordnance will reduce the costs of cleanup. There is a need to avoid the generation of potentially harmful by-products and hazardous wastes during manufacture, testing and training. The wastewater from TNT LAP operations commonly called “Pink Water” is costly to treat and produces a secondary hazardous waste. Note that if hazardous components were eliminated such that pink water is not generated during the demilitarization of new munitions, the generation of pink water from demilitarization operations of legacy munitions would continue.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Potential alternative materials and technologies will be developed for current methods

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: Solventless Manufacture of Artillery Propellant Using Thermal Plastic Elastomer Binder

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Multi-base gun propellant for artillery ammunition creates 0.3 lb. of solvent emissions per lb. of propellant with an estimated propellant production rate of 3 million lb./yr. The objective of this project is to demonstrate the feasibility of reducing or eliminating the emission of volatile organic compounds (VOCs) and solvents associated with the production of gun propellants by using thermoplastic elastomer (TPE) propellants. New reduced-solvent or solvent-less propellant formulations will be developed and evaluated for replacement of current propellants. This project demonstrated at a pilot plant scale, the production of TPE gun propellant by using solvent-less continuous processing.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Rheological characterization of 100 lb. propellant batch
- Determine grain and charge weight for initial gun firings
- Approve first 500 lb. lot of propellant for gun firings
- Complete process demonstration
- Define twin screw extruder operating window
- Determine grain and charge weight for second gun firings
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Sustainable Green Manufacturing**BUDGET ACTIVITY:** 2**PROGRAM ELEMENT:** 0602720A**IS THIS A CONGRESSIONAL INTEREST ITEM?** Yes.

DESCRIPTION: The objective of this project is to conduct research addressing pollution prevention and life cycle environmental quality issues that impact the Army. It will augment the efforts to bring the Army in compliance with the 50% reduction in pollutants as required by Executive Orders 12856 and 13101 and reduce weapon system corrosion maintenance costs 25% by the year 2005. This project also will: promote acquisition reform objectives and reduce life cycle costs and environment quality, safety, and health risks. This project will conduct research to address technological needs in areas of overlap between environmental stewardship and the sustainability in armaments' Environmentally Friendly (Green) Alternatives.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- M119 Base Plate Redesign
- Cylindrical Magnetron Sputtering (CMS) Target
- Life-Cycle Modeling for Ammunition (PM-Tank and Medium Caliber Armament Systems)
- Development of an accelerated corrosion test protocol for the ACT Facility at Aberdeen Proving Ground
- Mixing and Characterization of Meta-stable intermolecular composites
- Down select and develop a non-destructive test method for Depleted Uranium corrosion on the M829A2
- Environmentally friendly coating for the medium caliber gun barrel
- Cadmium replacement for threaded fasteners
- Prove-out testing for Powder Coating at Corpus Christi Army Depot
- Identified applications of ion beam process for corrosion inhibition

ANNUAL PERFORMANCE REVIEW: Met all performance objects for FY99.

POLLUTION PREVENTION:

HAZARDOUS MATERIAL REDUCTION

PROJECT SUMMARY

TITLE: Advanced Self-Polishing, Reduced Copper Coatings

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will demonstrate new generation, reduced copper release antifouling (AF), self-polishing coatings for use on Navy ships and submarines. Several new coatings will be tested both in the lab and in field studies to determine their copper release rates and fouling prevention characteristics. The results will be compared to currently used copper ablative AF coatings. If results indicate copper release rates lower than current AF coatings, then these new coatings will be considered as marine pollution control devices (MPCD) as stipulated under the Uniform National Discharge Standards (UNDS) legislation.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Select candidate coatings for testing and prepare test panels
- Initiate static, in-situ and dynamic exposure testing in the lab and in the field
- Initiate copper speciation measurements

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Alternatives to Solvent-Based Ink and Paint Stenciling for Identification Markings

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Identification marking methods are used throughout U.S. Department of Defense (DoD) manufacture and repair processes to mark codes and other information on defense system components and assemblies. Traditional marking materials, such as conventional inks and paints, often contain volatile organic compounds (VOCs), such as methyl ethyl ketone and toluene, which evaporate into the atmosphere during drying. Government and industry partners agreed that alternative inks and self-adhesive labeling should be evaluated as replacements for common identification marking methods. This ESTCP project will validate environmentally acceptable identification marking materials and processes that reduce or eliminate VOC emissions. In addition, this project will demonstrate the operational use of the validated alternatives.

This project addresses identification marking of a wide range of components and substrates, including marking electronics cabinets and cabinet parts; aluminum, steel, and stainless steel sheet and parts; and nonmetallic materials, painted metal surfaces, and elastomers. Alternative inks, including waterborne and ultraviolet-curable inks, were selected for consideration because they can be implemented quickly and inexpensively. Self-adhesive labeling was also selected for further consideration because it has the potential to significantly reduce labor requirements and almost completely eliminate the environmental, safety, and occupational health impact of identification-marking activities. The selected alternatives will be tested against validation requirements identified by government and industry partners, and the validated alternatives will be implemented at a number of DoD facilities. Tobyhanna Army Depot, Pennsylvania, and Norfolk Naval Shipyard, Virginia, are among the facilities at which acceptable alternatives may be implemented.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Begin Phase I validation testing
- Submit Demonstration Plan to ESTCP

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Automated Underwater Hull Maintenance and Monitoring System

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will demonstrate an underwater vehicle system for hull maintenance that will provide the following: propulsive fuel savings from underwater hull cleaning of marine fouling; assist in meeting toxic discharge prohibitions and requirements; reduced life cycle hull maintenance costs by monitoring the status of various underwater hull systems. Specifically, this project will demonstrate the ability of an underwater, remotely piloted vehicle, to sense hull fouling, engage cleaning tools to remove the fouling and capture and contain the toxic paint residue for further treatment and discharge.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete the integration and demonstration of hull sensors, cleaning tools and toxic paint capture and treatment technologies in the laboratory and in the field
- Complete transition documentation

ANNUAL PERFORMANCE REVIEW: Met all performance objectives. This project was completed and transitioned to NAVSEA, SEA 006 for implementation.

PROJECT SUMMARY

TITLE: Composite Materials Alternatives/Consolidation

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 06063721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Current navy stocking procedures for composite materials results in large amounts, up to 88%, of unusable material that is discarded as hazardous waste. The objective of this project is to reduce the amount of bulk waste, both hazardous and non-hazardous, through materials consolidation and improvements in shipping/handling/storage. This program will streamline the supply requirements for composite repair of aging, current, and future aircraft programs.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Pull together the NADEP surveys to develop recommendations for material consolidation and management
- Develop recommendations
- Research requirements for implementation of materials without qualification requirements
- Implement new material management and packaging requirements
- Develop test plan and cost analysis for qualification of materials with multiple platforms

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Convergent Spray Technology

BUDGET ACTIVITY: 6

PROGRAM ELEMENT: 0605854F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will optimize the principle material characteristics of iron filled elastomeric material using convergent spray technology. This technology will be tested on applying Radar Absorbing Material to multiple aircraft weapon systems (e.g., the B-2 and F-117A). This is an Air Force led tri-service project.

ANNUAL PERFORMANCE OBJECTIVES FOR FY 99:

- Develop performance criteria
- Complete test plan to demonstrate convergent spray technology

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Environmentally Advantaged Substitutes for Ethylene Glycol for Aircraft Ice Control

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Ice control chemicals are a major source of pollution in storm water discharge from airfields. Deicing and anti-icing of aircraft is currently accomplished using fluids containing high concentrations of ethylene glycol, a toxic substance which is listed as a U.S. EPA Hazardous Air Pollutant, or propylene glycol. Both glycols are extremely biodegradable and impart a very high biological oxygen demand (BOD) loading on receiving waters. In addition, commercially available ice control fluids contain additives such as corrosion inhibitors, surfactants, and thickening agents which have been shown to increase the toxicity of the fluid towards aquatic organisms. Large airports have already begun to implement expensive, large scale containment and treatment facilities in order to meet EPA storm water discharge permit requirements. The projected cost of implementing these controls and treatment systems at DoD installations is on the order of hundreds of thousands of dollars per year per installation. The objective of this program is to develop and characterize a high performance, environmentally benign aircraft ice control fluid which can be safely released to the environment without the necessity of post-treatment. A novel, self-remediating fluid formulation will be developed and tested over the course of this three year research and development program. The self-remediating fluid will contain microencapsulated enzymes which are tailored to degrade the fluid in low temperature environments. These enzymes will be released upon fluid application and will substantially degrade the fluid before it reaches the storm sewer outfall.

This technology was cooperatively funded by SERDP and the Air Force in FY 99 (see p. D-35).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Evaluate rheological behavior of thickening agents
- Complete Tier 1 evaluations of thixotrope/freezing point depressants (FPD) combinations
- Complete water quality sensitivity study
- Select FPD candidates
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Environmentally Benign Deicing/Anti-Icing Technology**BUDGET ACTIVITY:** 2**PROGRAM ELEMENT:** 0605502F**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The objective of this project is to develop a more environmentally friendly anti-icing fluid that can be used without the need for capture or treatment before release into the environment. This will be accomplished using fluids comprised of glucose, lactates, and their salts, as opposed to current glycol-based fluids.

Earlier research demonstrated the technical feasibility of this technology. Current research is directed at improving fluid characteristics, and fully testing novel fluids against Society of American Engineers AMS 1424 and 1428 standards. Near term commercialization of the proposed systems is assured by the abundant supply of low cost agricultural products (glucose, lactate and their salts), low cost processing, and numerous customers with a vested interest in market expansion for materials.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete testing on corrosion, frictional slip, and biological/chemical oxygen demand
- Complete analyses on viscosity, freezing point determination, and pH

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Environmentally Friendly Fire Fighter Training Facilities (FFTF)

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to demonstrate an environmentally compliant Fire Fighter Training Facilities (FFTF) that uses low-emission burners and a recyclable wastewater freed of AFFF. Operation of Navy propane-fueled FFTFs produces air and water pollutants that are marginal in meeting environmental ordinances. These facilities are uniquely designed to simulate submarine compartments, surface ship spaces, and open decks. However, changing environmental regulations are imposing compliance criteria upon these training facilities that were not addressed in the original designs developed more than eighteen years ago. Operation of Navy FFTF produces large amounts of air and water pollutants. Most FFTFs are now operating under waivers from local air quality management districts because they are only marginal in meeting local environmental ordinances. To create realistic shipboard and submarine fire conditions, propane flames are starved for oxygen to obtain bright yellow flames that result in air emissions. In addition, the AFFF surrogate chemical causes problems when FFTF wastewater effluent is discharged to state-of-the-art wastewater treatment plants that rely on biological processes. Appropriate control technologies are needed to permit FFTF to continue their vital mission while complying with local, state, and federal regulations. Methods to reduce emissions need to be specifically developed and tested to meet Navy requirements.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Conduct performance validation tests for wastewater treatment system
- Develop prototype air pre-mixing burner
- Conduct burner performance validation tests
- Air pre-mixing burner to provide 30% reduction of carbon monoxide, unburned hydrocarbons, and other pollutants while maintaining same flame luminosity, radiation heat, and training requirements
- Foam separation system will reduce foam concentration to <50 ppm

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Environmentally Preferred Engine Coatings

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: There are nearly 200 hard chrome plated engine components in the J52 engine and majority of these components are periodically removed and refurbished during the routine maintenance. Chromium plating baths contain chromic acid, in which the chromium is in the hexavalent state. Hexavalent chromium is a carcinogen and has a level of toxicity greater than arsenic or cadmium. Therefore, the plating operations must meet the EPA emission standards and OSHA permissible exposure limits. The goal of this project is to evaluate and determine if the plasma assisted nitriding and chromium ion plating processes are viable and cost effective alternatives to conventional hard chrome plating.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Identify the coating thickness and substrate materials
- Plasma assisted nitriding and chromium ion plating of test coupons – 3/99
- Microstructural evaluation of plasma assisted nitride and chromium ion plating test coupons
- Wear and environmental resistance of test coupons

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Evaluation of Aqueous Aircraft Parts Washers

BUDGET ACTIVITY: 6

PROGRAM ELEMENT: 0605854F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will identify, test, and evaluate material characterizations to determine the effects of aqueous parts washers used on aerospace components across the Air Force. It will validate aqueous cleaning and cleaners on various metals, alloys, and part configurations with a focus on reducing volatile organic compounds (VOCs) emissions.

ANNUAL PERFORMANCE OBJECTIVES FOR FY 99:

- Survey field units
- Evaluate aqueous parts washers and cleaners
- Document results

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Genetic Enhancement of an Anti-Freeze Protein for Use as a Substitute for Ethylene Glycol for Aircraft Deicing

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: There is an urgent need to develop environmentally benign deicers because of recently passed EPA regulations which make the continued use of traditional anti-icing/de-icing agents prohibitively expensive. Traditional glycol anti-icing/deicing agents (ethylene & propylene glycol) are effective in lowering the freezing point of water mixtures by the phenomenon of freezing point depression based solely on the molal concentration. The key environmental concerns of these ice control fluids are high biological oxygen demand (BOD) and toxicity (human/mammalian and aquatic) resulting in extensive costs associated with the collection and cleanup associated with their use. Additionally, a recent Air Force policy has been issued banning future purchase of ethylene glycol. In order to meet this challenge, Aspen System's project objective is to produce novel anti-icing/deicing agent using naturally occurring antifreeze proteins, which have a very low BOD and toxicity. Initial research has indicated that the insect *Dendriodes canadensis* antifreeze protein produces a freezing point depression that is 300 to 500 times the predicted value based on its molal concentration due to non-colligative properties. This project proposes to genetically alter the *Dendriodes canadensis* antifreeze protein gene in order to enhance the freezing point depression capabilities and therefore increase its usefulness and value as an aircraft deicing/anti-icing agent.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- DNA Oligonucleotide Synthesis
- Gene mutation & bacterial cloning
- DNA Sequence Analysis
- Yeast Cloning, Selection & Analysis
- Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Handheld Laser Cleaner/Coatings Remover

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0605854F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop a prototype, handheld Neodinium-YAG (Nd-YAG) laser employing a fiber optic delivery system for the precision cleaning of organic contaminants and removal of organic coatings from various substrates. Equipment will eliminate hazardous chemicals and materials currently used for cleaning/stripping operations, process emissions, and worker exposure concerns.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Assemble and demonstrate the prototype unit
- Verify units ability to effectively remove organic coatings

ANNUAL PERFORMANCE REVIEW: Met all performance objectives. This project will be transitioned to ESTCP in FY00.

PROJECT SUMMARY

TITLE: Hazardous and Other Ship Wastes – Shipboard Hazardous Material Substitution

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to identify, qualify, and document alternative materials and/or processes to replace or minimize the use of hazardous materials aboard surface ships and submarines. Thousands of hazardous materials are used on Navy ships and submarines, including paints, solvents/degreasers, cleaning agents, adhesives, sealants, lubricants, hydraulic fluids, rust/corrosion inhibitors, acids, alkalis, ethylene glycol, and miscellaneous maintenance materials. A large proportion of the hazardous waste stream generated by Navy shore facilities originates from used/excess hazardous materials offloaded from vessels. A wide variety of laws, Executive Orders, and Navy policies affect the management of shipboard hazardous materials, either aboard ship or once they are classified as hazardous waste when offloaded to the pier. Requirements are derived from the Clean Water Act, Toxic Substances Control Act, Resource Conservation and Recovery Act, Clean Air Act, Executive Orders 12856, 12873, and 13101, and CNO policies (OPNAVINSTs 5090.1B, 5100.19C, 4110.2; OPNAV Publication P-45-113-93). Less-hazardous or non-hazardous substitutes will reduce procurement costs, enhance shipboard safety and health, and reduce the tracking and disposal costs associated with hazardous materials.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- For surface ships, continue prioritizing hazardous materials for reduction/elimination based on ship procurement records and evaluating candidate substitutes against environmental, safety, and health criteria; efforts were to focus on adhesives and sealants (class II materials) and lubricant products (class VI materials)
- For submarines, develop a prototype version of a single computerized reference and management tool, the Submarine Hazardous Materials Inventory Management System (SHIMS), for all submarines that consolidates currently separate sources of information and guidance

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Hazardous and Other Ship Wastes – Shipboard Hull and Topside Paints

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to identify and qualify new commercial paints and coatings and state-of-the-art ship preservation practices that: comply with recent and anticipated environmental regulations pertaining to volatile organic compounds (VOCs), hazardous air pollutants (HAPs), particulate matter (PM), and hazardous paint wastes; enhance the safety and health of ship's force and other maintenance workers; and provide significant labor avoidance and pollution prevention through longer service life and extended ship maintenance periodicities. The regulatory drivers are at the national level (National Emission Standards for Hazardous Air Pollutants (NESHAPs) and National Ambient Air Quality Standards (NAAQS) under the Clean Air Act), regional level (e.g., the South Coast Air Quality Management District in southern California), the state level (e.g., California, Connecticut, and Pennsylvania), and the local level (e.g., the San Diego Air Pollution Control District). Improved materials and techniques will produce substantial cost savings in application, removal, and maintenance (inspection, cleaning, recoating) of shipboard paints and coatings.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop coating test criteria (edge retention, surface tolerance, materials compatibility, cleanability, life-cycle modeling, etc.)
- Qualify solvent-free (low-emissions), edge-retentive coatings for ballast tanks, CHT tanks, fuel tanks, and bilge spaces through shipboard demonstrations
- Conduct laboratory testing of low solar absorbance (LSA) anti-stain paints for topside applications
- Develop and demonstrate a non-invasive electrochemical monitor for ballast tanks as condition-based maintenance (CBM)

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Hazardous and Other Ship Wastes – Shipboard Pollution Prevention

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective is to identify, test, and document commercial off-the-shelf (COTS) or non-developmental pollution prevention (P2) equipment that can be expeditiously transitioned to the Fleet. Reductions in shipboard hazardous materials use will be instrumental in facilitating compliance with Navy homeport pollution prevention requirements driven primarily by Executive Order 12856 (Pollution Prevention and Right to Know in the Federal Government) and the U.S. Public Vessel Medical Waste Anti-Dumping Act. Equipment selected for transition to the Fleet must demonstrate a positive return on investment in terms of reduced hazardous material procurement costs, reduce hazardous material offload, handling, and disposal costs, and improved safety and health conditions.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Install 14 P2 opportunities on USS RUSHMORE (LSD-47) and evaluate their performance during deployment
- Prepare a test plan for aerosol can puncturing devices
- Prepare the final report for LHD-1 Class P2 opportunities
- Initiate a study of steam cleaning for the Close-In Weapons System (CIWS)
- Identify additional candidate P2 opportunities as appropriate
- Support the “Jump Start” transition program, wherein selected high-payback P2 opportunities were to be installed on 16 ships in advance of the Fleet-wide implementation to start in FY00
- Identify candidate commercial medical waste processing equipment for shipboard evaluation

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Isocyanate-Free Aircraft Topcoat

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0605854F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project was designed to identify, develop, and evaluate isocyanate-free aircraft topcoat technologies that meet all technical, environmental, health, safety, and performance requirements. The environmental benefit is the reduction/elimination of isocyanate emissions from painting operations with improved worker safety through reduced airborne hazards.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Test plan to screen and evaluate sample non-isocyanate formulations
- Test panels coated and subjected to the requirements for aircraft coating qualification
- Reformulation of promising chemistries

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Lubrication Free Compressor**BUDGET ACTIVITY:** 6**PROGRAM ELEMENT:** 0605854F**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: This project evaluates innovative use of active magnetic bearings to eliminate the use of lubricants in units (e.g., heat pumps) using environmentally safe alternative refrigerants. (i.e., HFCs). This system retrofit significantly improves unit efficiency, eliminates ozone depletion potential through the use of HFC class refrigerants, and lowers energy costs. This project is funded jointly with the Ballistic Missile Defense Organization (BMDO) and the State of Florida.

ANNUAL PERFORMANCE OBJECTIVES FOR FY 99:

- Retrofit refrigerant units with active magnetic bearings system and alternative HFC class refrigerant
- Validate and document results

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: New Environmentally Friendly Deicing Material Compatibility Testing

BUDGET ACTIVITY: 6

PROGRAM ELEMENT: 0605854F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project funds compatibility testing of alternative deicing materials to replace the currently banned urea compound. Potential replacement materials or material combinations will be tested to develop a database of results. Considerations include adverse effects on engines, maintenance costs, part replacement costs, and significant increases to aircraft downtime. EPA regulations are headed toward deicing materials with zero discharge of pollution to waterways.

This technology is cooperatively funded by the Air Force and SERDP in FY99 (see p. D-23).

ANNUAL PERFORMANCE OBJECTIVES FOR FY 99:

- Demonstrate and validate military method for qualifying deicing materials and material combinations, analyze, and document results

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Non-Chromated Primer

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to facilitate and manage the demonstration/validation process for the application of non-chromate paint primer used on military aircraft.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Qualification testing; establish GSA sources
- JG-PP Technical Meeting

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Non-Cyanide Silver and Copper Plating**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: Cyanides are hazardous air pollutants as defined by the Clean Air Act (CAA) and are targeted for reduction/elimination. The goal is to evaluate Techni-Silver Cy-Less L2 and E-Brite 50/50 non-cyanide silver and E-Brite 30/30 non-cyanide copper plating formulations and the resultant plated material as potential replacements for current NADEP formulations. This project will survey literature and other sources for other non-cyanide alternatives and evaluate as appropriate. It will also demonstrate, validate and certify these non-cyanide plating alternatives to naval aviation systems requirements.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Gather technical data on Techni and E-Brite products
- Purchase 10 gallon laboratory samples
- Meet with depot personnel to define application criteria for Ag and Cu plate
- Complete laboratory evaluation of 10 gallon baths
- Initiate depot-level evaluation of promising alternatives
- Investigate other alternative compositions

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Non-Polluting Composites Remanufacturing and Repair for Military Applications

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: DoD and DOE use of polymer-matrix composite (PMC) materials is on the verge of an unprecedented increase. Some of the major DoD programs already or planning to implement PMC include: Army's Comanche helicopter, Composite Armored Vehicle (CAV), Navy's Advanced Enclosed Mast Sensor System (AEMSS) and Composite Bumpers, and various aircraft components. The primary concerns with composite materials are remanufacturing and repair of structures at DoD bases and facilities. Conventional remanufacturing operations involve the reconstruction of parts and components using similar processes for prepreg layup and autoclave curing used to produce the original structure. These fabrication techniques may produce any number of potentially polluting wastes, including uncured trim from prepregs, solvent emissions from prepregs and adhesives, cured trim solids, bagging films, and bleeder plies. In addition, stored prepregs that have exceeded their shelf-life cannot be used for military structures and must be disposed of in landfills.

The technical objective of this program is to research, develop, and demonstrate a unique, affordable, environmentally friendly family of PMC manufacturing and repair technologies for stand-alone repair of current, soon-to-be-fielded, and future DoD structures. Pollution prevention technologies associated with vacuum assisted resin transfer molding (VARTM) and various curing technologies including electron beam and ultraviolet light of composites and adhesives and recycling of fabric prepregs will be advanced. Repair concepts and technologies will be demonstrated on three DoD-specific problems.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop surface preparation and on-component application methods for e-beam prepreg
- Investigate building-block approach to large structure development
- Thermal and e-beam cure cycle development
- Rheological characterization/compounding of adhesives to enhance application to panel repair and aluminum bonding.
- Quantify cure behavior on pot-life and processing time for patch/fill VARTM repair
- Initiate mechanical property characterizations of adhesives
- Initiate repair methods for ballistic tested composite armor panels
- Investigate effect of scale-up and cure/cycle on mechanical properties in air-craft skin repair
- Develop VARTM-based repair technologies developed
- Initiate evaluation of property knock-down in damaged composite panels
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Nonpolluting Marine Lubricants

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Oily wastewater from steam catapults aboard Navy carriers is being discharged into the surrounding water, which causes a visible sheen and is in non-compliance with regulations. Methods to control these discharges have been identified as the number one priority for AIRLANT and AIRPAC type commanders. This task will develop a “drop-in replacement” for existing mineral lubricants that will provide similar performance and comply with environmental requirements.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Conduct full formulation performance & evaluation tests
- Refine formulations as required
- Test refined formulations

ANNUAL PERFORMANCE REVIEW: Met all performance objectives. This project was completed and transitioned to NAVAIR, PMA 251 for field testing.

PROJECT SUMMARY

TITLE: Pesticide Reduction through Precision Targeting

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Department of Defense (DoD) presently uses approximately 1 million lbs. of pesticide active ingredient annually, excluding pesticides used during major deployments. In each of these settings, these pests and disease vectors also affect the health of DoD personnel by transmitting pathogens, contaminating foods and surfaces with biologics, and producing allergens. The overall research goal is to reduce pesticide use and risks through the use of precision targeting and comparative risk reduction. This will result in the development of a comprehensive, standardized, verifiable, and documentable system for protecting troops, DoD supplies, and DoD facilities from disease vectors and pests in a manner that reduces pesticide use and risk. This novel precision targeting approach to integrated pest management (IPM) will reduce pollution from pesticides while ensuring control of disease vectors and pests that impact military readiness in three major settings: (1) in military deployments and training exercises, vector-borne diseases, such as malaria, leishmaniasis, dengue, and tick borne illnesses transmitted by mosquitoes, flies, and ticks, cause direct loss in troop combat effectiveness; (2) in the DoD supply system and in DoD supply depots, stored products pests and other pests cause losses to war stocks of military rations and other material such as uniforms and blankets with losses increasing during longer storage times; and (3) on military installations, a wide range of pest species cause damage to buildings, structures, and vegetation.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Beta test with Army personnel on site for integration of pesticide reduction and precision targeting hardware/software into routine operations
- Complete beta testing system in hands of Army personnel on turf applications at Ft. Meade
- Beta test with Air Force personnel on site for integration of pesticide reduction and precision targeting hardware/software into routine operations at Little Rock AFB
- Complete beta testing system in hand of Navy personnel on shipboard cockroach mitigation at Navy port installation
- Fine tune all components of software based on hands-on testing by DoD personnel
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Ship Rag Cleaning and Recycling Technology

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Navy ships generate approximately 600,000 lbs of oily rags at a disposal cost of over \$700,000 per year. These oily rags represent the third largest quantity of hazardous waste disposed from ships. This task will use liquid CO₂ combined with soluble surfactant technology to clean used industrial rags aboard ship to permit reuse of those rags in shipboard maintenance operations. This task will also select an efficient surfactant system, establish acceptable “cleanliness” criteria for recycled rags, and develop a preliminary design for a shipboard prototype.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Establish rag “cleanliness” criteria
- Define shipboard operational parameters, requirements and constraints
- Initiate surfactant package evaluation with liquid CO₂ cleaning

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Source Reduction of Toxic Metal Waste Streams

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to optimize the large scale treatment of model wastewater solutions and then verify the method by treating authentic wastewater from NADEP plating shops to below discharge limits. The ultimate goal of this project is to implement the process at a NADEP IWTP and demonstrate its success through acceptable on-line performance.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Demonstrate acceptable removal of metals using model wastewater solutions
- Coordinate efforts with each of the depots to address IWTP concerns about treatment method
- Obtain authentic wastewater samples from NADEP depot plating shops
- Treat, analyze, and optimize acceptable removal of metals from authentic wastewater samples
- Certification of the source treatment facility by NAVFAC/NFESC

ANNUAL PERFORMANCE REVIEW: Met all performance objectives. Transferred to Naval Facilities Engineering Command.

PROJECT SUMMARY**TITLE:** Submarine Heat Exchanger Fouling Control**BUDGET ACTIVITY:** 2**PROGRAM ELEMENT:** 0602121N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: Marine fouling of mission-critical heat exchangers is a chronic problem for Navy submarines. Cleaning fouled heat exchangers is costly and significantly degrades overall ship availability. The primary approach to control biofouling has been the use of aqueous chlorine; however, discharge of chlorinated seawater from submarine cooling systems violates environmental discharge regulations. Dechlorinating systems would have to be designed, fabricated, and implemented to continue the use of chlorine. This task will investigate and develop pulsed power acoustics technology for seawater heat exchanger fouling control and thereby eliminate the use of chlorine.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Conduct pulsed power acoustics proof-of-concept tests in the field
- Conduct selected laboratory evaluations of sub-components
- Complete SBIR Phase I Bio-fouling monitor task

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Advanced Low Pollution Coating (ALPC) Development

BUDGET ACTIVITY: 6

PROGRAM ELEMENT: 0605854F

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: The objective of this project is to develop and implement low pollution coatings for turbine engine airfoils using the chemical vapor deposition (CVD) process. This project will define the technical and hardware requirements, developing the recoating process, and required testing and evaluation. Candidate airfoils benefiting from this technology include turbine blades and vanes from the F-101, F110, and F100 series engines.

ANNUAL PERFORMANCE OBJECTIVES FOR FY 99:

- Define technical requirements for hardware
- Determine qualification criteria for recoating

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

POLLUTION PREVENTION:
NON-HAZARDOUS SOLID WASTE REDUCTION

PROJECT SUMMARY**TITLE:** Glass Bead Residue Leasing/Recycling**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The objective of this project is to implement the floor-matting and media vacuum system. An evaluation of the impact on production turnaround time and the labor associated with clean-up processes will be performed. Utilizing reclassification equipment, evaluate the effectiveness of reclassifying open blasting glass beads for reuse. Examine the effectiveness of reclassification by performing some media size classification and media cleanliness examinations. The lease contract has limitations on the percentage of floor sweeping compound that can be returned with the glass bead waste. In an effort to optimize the cost savings within the glass bead open blasting process, it is important to explore the possibility of re-utilizing the media prior to hazardous waste disposal under the lease contract.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Certify and implement lease agreements to reduce hazardous waste

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Wipe Rag Recycle**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The objective of this effort was to identify and demonstrate the best technology available, including its operating parameters, for cleaning rags contaminated with naval wastes. The Navy generates large quantities of soiled wipe rags from cleaning and maintenance operations that are costly to procure and dispose of. Commercial cleaning services that supply and clean rags are not available to activities OCONUS, nor are they equipped to clean rags potentially contaminated with RCRA regulated wastes. In addition, commercial services are often impractical for naval ships based on their historically high rag loss rate, which significantly increases the cost. To address these markets, an ozone laundry system was developed to recycle soiled rags. The ozone system was demonstrated at the existing Naval Public Works Center San Diego conventional oily rag laundry. Results show that when compared to the conventional hot water laundry process, rags cleaned using the ozone process were significantly cleaner. In addition, costs for rag cleaning were reduced by 27% and chemical oxygen demand (COD) in wastewater was reduced by 71%.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Optimize cleaning process by conducting supplier tests
- Purchase equipment
- Conduct field demonstration
- Cleaned rags will have improved water absorbency over conventional process
- Wastewater generated from process will have lower COD levels
- Cost of new cleaning process will be lower

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Resource Preservation Initiative - Investment Recovery (IR)

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: The Navy's investment in the material it disposes is measured in procurement and disposal costs. Currently in the Navy there is no organized regional investment recovery program or strategy. The effectiveness of investment recovery programs at installations within the region varies from 16 to 53 percent of solid waste recycled. When benchmarked to the private sector, Navy installations could be achieving results of 70 percent or more of solid waste recycled.

The regional IR Program will remove barriers between installations that restrain integration and sharing of personnel and equipment resources. Regional management of the solid waste budget will link disposal costs directly with the benefits of investment recovery. Regionalization of investment recovery will also put in place the structure that will enable installations to share resources, provide reimbursable services to each other, take advantage of economies of scale, and avoid the need for duplicate technology.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Preparation of a Project Management Plan (PMP)
- Preparation of a specification and quality plan for an Investment Recovery Information System (IRIS)

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

POLLUTION PREVENTION:

ODC REPLACEMENTS

PROJECT SUMMARY

TITLE: Next Generation Fire Suppression Technology Program (NGP)

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The NGP has been restructured to a 9-year, \$20 M effort, of which two thirds has been committed through FY2000. As a result, the objectives have been reduced to address aircraft issues only. The goal of the revised program is to develop and demonstrate, by 2005, technology for economically feasible, environmentally acceptable and user-safe processes, techniques, and fluids that meet the operational requirements currently satisfied by Halon 1301 systems in aircraft. The focus on aircraft stems from the reliance of the aircraft survivability engineering teams from all three Military Services on NGP research to meet their fire suppression needs. Thus, this updated program: addresses the predominant fires occurring in aircraft dry bays and engine nacelles; does not include fuel tank inerting since the Air Force is in the final stages of evaluating CF₃I for this use; focuses resources on identifying and examining promising chemicals and precepts for their effective storage, dispersion and distribution; and pertains to both current and planned platforms.

Over the next two years, the NGP will deliver the following, building on NGP research to date: analysis of the world of useful chemicals, identification of the best places to look for alternative suppressants, and a first set of “best looks;” a suite of screening tests and guidance for their use; a method for determining and comparing the total life-cycle costs of new fire suppression technologies; and definition of what diagnostic information is needed to characterize the outcome (beyond flames out or not) of real-scale tests so that program managers have confidence in the program “products” they are considering. This program complements and is coordinated with all other ongoing service efforts to replace Halon 1301.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Delivery of final report, physiological model code, and data requirements
- Complete measurements of surface temperature changes as a function of aerosol impingement
- Completion of tiered toxicity evaluation approach with descriptions of applicable tests, decision considerations, benefits, limitations, timing and cost
- Obtain probability density functions of the variation in particle velocities as a function of impressed buoyancy forces to determine the effects of flame buoyancy on particles
- Identification of new agents for consideration
- Validation of chemical model against flame data for Potassium agents
- Complete flame species measurements on selected potassium agents
- Completion of screening of first set of compounds identified in FY1998 and identification of those meriting further serious consideration
- New Suppressant Generation Methods: Physical characterization of next generation additive-enhanced solid propellant formulations

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Non-CFC Cleaning of Oxygen Systems

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop an oxygen line cleaning process for aircraft oxygen systems that will eliminate the use of Class I ODS and CFC-113, which will allow the Navy to meet ODS and EPA requirements.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Technology Research
- Procurement of prototype major components
- Set-up of first prototype
- Validation test (flow and temperature)

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Ozone Depleting Substances – Shipboard CFC Replacement

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objectives are to develop shipboard air-conditioning and refrigeration (AC&R) plants for ships and submarines that use non-ODS refrigerants, without degrading the performance, reliability, maintainability, acoustics, or safety of existing cooling systems based on conventional CFC refrigerants. This will allow Navy vessels to continue operating in the commercial absence of CFC refrigerants, the production of which was banned by regulations under the Clean Air Act and amendments that implemented the Montreal Protocol on Substances That Deplete the Ozone Layer and subsequent international agreements.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Continue development of backfit kits for converting surface ship 125-ton, 150-ton, 300-ton, and 363-ton CFC-114 air-conditioning plants to operate on HFC-236fa (convert A/C plants in the laboratory for LSD-44, LCC-19, and AOE-6 Classes; convert two CFC-114 A/C plants on a CG-47 Class ship (USS NORMANDY, CG-60) and initiate an at-sea demonstration)
- Continue development of new state-of-the-art AC&R system designs for forward fit (conduct laboratory 2000-hr endurance test of the new-design 200-ton plant for DDG-51 FLIIA and LPD-17 Classes and future platforms; complete qualification of the new-design 1.5-ton refrigeration plant for DDG-51 FLIIA and future platforms)
- Complete at-sea evaluation of the first submarine refrigeration plants converted to HFC-134a
- Continue testing of submarine atmosphere monitoring and control systems (CO/H₂ burner, Central Atmosphere Monitoring System (CAMS), CO₂ scrubber, and gas management system) with non-CFC refrigerants and evaluate modifications to adapt the equipment to new refrigerants (complete the first long-term analysis of the Navy's existing burner catalyst; perform at-sea monitoring aboard an SSN-688 Class submarine; prepare specifications for competitive procurement of catalysts)

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Ozone Depleting Substances – Shipboard Halon Replacement

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective is to identify, demonstrate, and prepare performance specifications for alternative fire suppression agents and delivery systems to replace Halon 1301 used in shipboard total-flooding fire protection applications. This will allow Navy vessels to continue operating in the commercial absence of Halon firefighting agents, the production of which was banned by regulations under the Clean Air Act and amendments that implemented the Montreal Protocol on Substances That Deplete the Ozone Layer and subsequent international agreements.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete the design and instrumentation of the large Flammable Liquid Storeroom (FLSR) test compartment
- Initiate discharge testing of the Navy's alternative non-Halon fire suppression agent of choice (HFC-227ea) to support new-construction shipbuilding programs (LPD-17, CVN-76, CVN-77, and DD-21)
- Initiate preparations for small-compartment testing of water mist agent

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Reduction of Halon 1301 Release During System Testing**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The classification of Halon as an ozone depleting substance has intensified the scrutiny of any Halon emissions. Every 5 years, Navy aircraft fire extinguishing bottles are required by DOT regulations to undergo hydrostatic pressure testing. The test is performed to assess the structural integrity of the bottles. To conduct this test, the bottles must first be emptied of its contents, Halon. There are unavoidable inefficiencies associated with the Halon recovery process resulting in the accidental release of Halon 1301 into the atmosphere. Therefore, the goal of this project is to transition new fire extinguishing bottle maintenance procedures (hydrostatic test requirements) to all Navy aircraft, thereby eliminating or reducing accidental Halon 1301 discharges associated with the original maintenance procedure. Data analysis has now extended the 5 year requirement indefinitely. This has reduced Halon emissions.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Final test system check
- Baseline inspections
- Environmental testing
- Interim report
- Data analysis
- Final report and recommendations

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Shipboard Thermoacoustic Cooling**BUDGET ACTIVITY:** 3**PROGRAM ELEMENT:** 0603712N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: This task will demonstrate an electrically driven, 3-ton chiller (TRITON) using thermoacoustic-pumping technology to replace existing systems that use CFCs and global warming gases. The chiller is intended for shipboard and submarine use and will include instrumentation to accurately measure its thermodynamic performance (efficiency). This demonstration will show unit performance equal to or exceeding current vapor compression system specifications. Thermoacoustic technology will demonstrate high reliability due to reduced parts and no sliding seals, reduced manning due to reduced maintenance, no environmental toxic emissions, and potential for improved efficiency. This task has high probability for dual use application and is being seriously considered for joint research by several large commercial companies.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete component and sub-system fabrication and testing
- Complete integrated system laboratory check out and testing
- Initiate schedules for sea trials

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

POLLUTION PREVENTION:
PLATING AND METAL FINISHING

PROJECT SUMMARY

TITLE: Alternative Sealants and Bonding/Adhesives Material Substitution/Technologies in Composites

BUDGET ACTIVITY: 1

PROGRAM ELEMENT: 0601102A

IS THIS A CONGRESSINAL INTEREST ITEM? No.

DESCRIPTION: The manufacture and repair of composites involves use of hazardous sealing, bonding and adhesive materials. These materials pose health risks to workers and generate hazardous waste streams requiring management in compliance with RCRA. At present, the most predominant technology for composites involves thermal curing of thermoset resins, which have limited shelf-lives. After expiration dates, the uncured or partially cured materials must be disposed of as hazardous waste. Additional uncured or partially cured quantities of these materials enter waste streams during manufacturing and repair. VOCs and hazardous air pollutants are also released as the resins are applied. The Army needs to develop and implement new processes, materials, or technologies to eliminate the environmental impacts currently associated with composite repair.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop potential alternative materials and technologies for current methods

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: Aluminum-Manganese Molten Salt Plating

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The Department of Defense (DoD) is reducing and eventually eliminating its current reliance on cadmium-based coatings for aviation hardware due to the environmental hazards and threats to human health posed by cadmium, a toxic metal and a possible human carcinogen. Cadmium hazardous waste is transferred off-site to landfills, and airborne cadmium dust threatens workers in and around cadmium removal operations. Cadmium is even being found in the rinse waters of aircraft wash-downs. As a result, non-toxic substances must be found to replace the current coatings. Aluminum-manganese may provide the functional performance of cadmium without its toxic properties. Utilizing a molten salt bath, aluminum-manganese can be easily and inexpensively plated onto components, including internal diameters, complex geometries, and threaded applications. This project will demonstrate the efficacy of electroplated aluminum-manganese coatings in replacing the toxic cadmium coatings.

Under ESTCP sponsorship, the U.S. Navy, Air Force, and Army will participate in the development of a test protocol to verify the functional performance of aluminum-manganese as alternative to cadmium plating. The technical performance and life-cycle cost of molten salt-plated aluminum-manganese will be established. Aluminum-manganese will be evaluated for use on high-strength steels in aviation applications, such as landing gears and fasteners; and hydraulic, rotary, and threaded components. The functional performance evaluation of the aluminum-manganese coatings will assess whether sacrificial corrosion protection and lubricity without a fatigue debit greater than that of cadmium or an increased risk of hydrogen embrittlement as compared to that of cadmium on high strength steels is possible. Life-cycle costs of the aluminum-manganese plating process will be measured based on environmental, safety, and health considerations; and capital equipment, facilities, and operational and disposal costs. These costs will be estimated and then verified by the installation and operation of a 1,500-gallon molten salt-plating demonstration system at a naval aviation depot.

This technology was cooperatively funded by ESTCP, the Navy (see p. D-59), and the Air Force (see p. D-69) in FY99.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Optimize Manganese (Mn) concentration in plated deposit
- Develop test protocol for cadmium plating replacements on high strength steel landing gear
- Identify components, stakeholders, program managers, parts engineers, MIL SPEC custodians, and approval authorities for leveraged, full-scale fatigue testing for each service
- Develop preliminary test protocol for cadmium replacements on steel rotary components, threaded components, and fasteners
- Complete toxicological study of intermetallic AlMn compound and submit written report.
- Evaluate chromate/non-chromate post treatments
- Test Al-Mn in accordance with tri-service test protocol for cadmium plating replacements on high strength steel landing gear, rotary components, threaded components, and fasteners
- Complete initial cradle-to-grave, life-cycle cost analysis of Al-Mn
- Draft demonstration plan for Al-Mn molten salt plating system

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Cadmium Plating Replacements**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: Current environmental, safety and health regulations make it prohibitively expensive to use cadmium. There have been several potential cadmium replacements that have been developed. Molten salt plating of Aluminum-Manganese has the potential to be the best overall cadmium replacement. Aluminum-Manganese can be plated inexpensively onto parts with complex geometries, and internal diameters. The goal of this project is to demonstrate that Aluminum-Manganese can be plated onto full scale aircraft components as well as designing a prototype plating bath for installation at NADEP NI.

This technology was cooperatively funded by the Navy, the Air Force (see p. D-69), and the ESTCP (see p. D-58) in FY99.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Test Aluminum-Manganese in accordance with the Joint Test Protocol (JTP) for cadmium replacements (JTP contains over 20 different tests)
- Develop a test protocol for cadmium replacement on high strength steels
- Conduct preliminary test of Aluminum-Manganese plating for use in high strength steel applications
- Plate, inspect, strip and replate several full scale components
- Gain DoD/Industry buy-in on Molten Salt Plating of Aluminum-Manganese

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Critical Factors for the Transition from Chromate to Chromate-Free Corrosion Protection

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: There are no known acceptable alternatives for chromates in aluminum corrosion inhibition coatings. Since EPA and OSHA regulations are restricting the use of Chromium, there is a need to acquire a fundamental understanding of the chemical and/or physical processes and mechanisms of corrosion protection that occur when chromate-based coatings are applied on metal surfaces. The objective of this project is to understand the metallurgy of chromate-free corrosion protection. It focuses on the film formation processes involved in producing a protective surface. There are four major phases over four years: (1) Mitigating the negative effects of microstructural heterogeneity using Raman spectroscopy, microscopy and electrochemical tools; (2) Determining the feasibility of chromate-free active corrosion protection (self-healing); (3) Studying the effects of non-ideal application methods, service history and aging on structural, chemical and performance profiles of chromate conversion coatings; and (4) Developing accelerated, quantitative and predictive diagnostic test protocols to stimulate development and implementation of chromate-free coatings. Understanding of corrosion mechanisms and chromate passivation will provide a rational basis for design, selection and evaluation of new environmentally friendly replacements for chromate corrosion inhibitors and support the development of a deterministic basis for predicting substrate corrosion rates. Both will contribute to successful life extensions of DoD weapons systems. The work ties directly into an ongoing AFOSR-sponsored MURI at Ohio State University. The two projects complement each other and are not duplicate efforts.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Developed test methods
- Analyzed structures & props
- Amended coating procedures
- Completed Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Environmentally Compliant, Corrosion Resistant Surface Treatment and Primer Sol-Gel Coatings Technology

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602102F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The overall objective of this project is to further develop environmentally compliant, corrosion resistant surface treatments and primer Sol-Gel coatings technology. The proposed environmental benefit of this project is the elimination of hexavalent chromium, a known carcinogen, from aircraft surface treatments and primers. This will result in reduced hazardous material usage, reduced hazardous waste generation, reduced hazardous air pollutant generation, and improved worker environment. This project is part of an ongoing effort in surface treatment research being conducted at Oklahoma State University. Successful development will lead to initial in-service application testing on KC-135 aircraft at Oklahoma City Air Logistics Center, Tinker AFB OK.

This project was cooperatively funded by the Air Force, the Navy (see p. D-83), and SERDP (see p. D-94) in FY99.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Development of ORMOSIL coatings, containing inorganic silicate network and externally hydrophobic organic polymers as modifiers
- Review scientific issues concerning the development of technologies to achieve strong, durable, strongly bonded, corrosion protective coatings for aerospace alloys

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

Title: Evaluation of Non-Chromated Conversion Coatings for Aircraft Spray Applications

Budget Activity: 2

PROGRAM ELEMENT: 0602202F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective was to evaluate the performance of ten non-chromated conversion coatings identified as possible alternatives to the chrome-containing products currently sprayed to pretreat aluminum skinned aircraft. Environmental benefit is the elimination of hexavalent chromium, a known carcinogen, from aircraft surface treatments. Result is reduced hazardous material usage, reduced hazardous waste generation, reduced hazardous air pollutant generation, and reduced worker exposure.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Completion of laboratory testing, data evaluation, and final report preparation were planned

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Heavy Metals Alternatives for Internal Surfaces

BUDGET ACTIVITY: 6

PROGRAM ELEMENT: 0605854F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will identify and qualify replacement alternatives for plating complex internal surfaces. Project will explore realistic and cost effective alternatives to current internal plating techniques for implementation at depot operations.

ANNUAL PERFORMANCE OBJECTIVES FOR FY 99:

- Identify alternatives for plating complex internal surfaces; document results

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: High Velocity Oxygen Fuel (HVOF) Coatings Characterization

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602102F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective is to evaluate the properties and the performance of HVOF coatings. Ten sub-objectives include the evaluation of the coatings produced by equipment from the three major manufacturers, and the mechanical and metallurgical properties of coatings produced by different alloys and substrate surface preparation variables. The reparability of HVOF coatings will also be demonstrated. The environmental benefit of this project will come from the replacement of hazardous chrome plating maintenance activities, whenever possible, by the HVOF thermal spray process. This will result in the reduction of hazardous waste generation and hazardous air pollutants as well as improved worker safety.

This project was cooperatively/jointly funded by the Air Force, ESTCP (see p. D-71), and the Navy (see p. D-65) in FY99.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

During this period a test plan matrix was to be developed, test specimens were to be obtained, facilities to coat and finish the HVOF and hard chrome specimen were to be identified, and laboratory testing was to begin.

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: HVOF Coatings as a Hard Chrome Plating Replacement

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Hard chrome plating is a technique that has been in commercial production for over 50 years and which is a critical process associated with maintenance activities at all Naval aviation depots. Chromium plating baths contain chromic acid, in which the chromium is in the hexavalent state, with hexavalent chromium (hex-Cr) being a known carcinogen having a level of toxicity greater than arsenic or cadmium. Perform all fundamental testing, develop prototypes and demonstrate HVOF as a viable, and beneficial alternative to conventional hard chrome plating.

This technology was cooperatively funded by the Navy, the Air Force (see p. D-64), and ESTCP (see p. D-74) in FY99.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Finalize design of HVOF cell; Initiate procurement of HVOF cell.
- Develop prototype F404 conical shaft
- Complete: (1) F/A-18 MLG fatigue test; (2) Complete coupon matrix study
- CH-46 generator gear endurance test
- Finalize prototype list to implement flight test plan (Jax)
- Obtain and coat prototype components
- P-3 bomb bay door actuator pistons
- Identify and coat prototype engine components
- P-3 test flight program
- Monitor performance of the following field test components: (1) J52 rear compressor drive turbine shaft; (2) EA-6B landing gear prototype; (3) J52 MOP spur drive gear; (4) Fatigue test AV-8B landing gear pin with HVOF coating; (5) CH-46 generator gear field test; (6) Coat scrapped H-60 tail landing gear pistons.

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Materials And Radio Frequency / Electro-Optics / Infrared Electronics Technology

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602234N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This program provides applied research to support all Navy advanced weapon and platform system concepts and needs in the areas of materials and electronics technology. Developmental tasks address significant improvements in terms of affordability; performance; and reliability to effect transition of advanced technology to the Navy fleet. Environmentally acceptable coatings are being developed for both aircraft and ships and the maintenance of the Navy pier and wharf infrastructure for surge capacity.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Demonstrate non-toxic trivalent chromium coating for pre-treatment of aluminum alloys and post-treatment of anodized aluminum
- Initiate environmentally acceptable coating system development for non-magnetic ship hulls required for stealth and mine countermeasures

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Non-Chromate Sealers for Aluminum Anodizing

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The chromate anodizing process that is used to finish a wide variety of weapons system components results in the release of toxic air emissions and the generation of liquid and solid wastes at U.S. Department of Defense (DoD) manufacturing facilities. This project will demonstrate the operational use of nonchromate sealing processes that can eliminate the need for chromated sealers in the sulfuric acid anodizing process.

Anodic coatings, which are used primarily on aluminum alloys to provide increased resistance to corrosion and wear, are porous and are normally sealed with sodium dichromate. Dichromate seal is considered the industry standard and is widely used by Department of Defense (DoD) depots and original equipment manufacturers (OEM) in the production and maintenance of defense material. Developmental tests performed under the Strategic Environmental Research and Development Program (SERDP) showed that the use of nonchromate sealers provided performance comparable or better than the standard dichromate sealer. For example, nonchrome sealers successfully passed extended (more than 3,000 hours) salt spray testing.

To demonstrate the feasibility of producing nonchromate sealers at normal production rates using production hardware, a nonchromate sealing process will be installed in a DoD anodizing line. Tentative DoD production environments include the U.S. Air Force Oklahoma City Air Logistics Center, the Naval Air Station at Jacksonville, and the Air Logistics Center in Ogden, Utah. Following the processing of component parts, the performance of the sealers will be validated according to military (MIL) and American Society for Testing and Materials (ASTM) performance and quality assurance requirements.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete Joint Test Protocol (Air Force)
- Submit Demo Plan
- Approve Demo Plan
- Install Non-Chrome Process
- Optimize Process Parameters
- Complete Demonstration
- Conduct Quality Assurance Tests

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Non-Chromated Conversion Coatings

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will demonstrate: the functional performance of conversion coatings applied by trivalent chromium based solutions in the laboratory and field; that environmental, health and safety concerns are dramatically decreased by the use of trivalent chromium based solutions; and, ease of application of TCC at Naval Depots. This project will certify the tri-valent based formulations for use on naval aviation systems.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete lab testing of TNP pen
- Complete initial lab testing of NI S-3 paint system
- Field testing of TNP pen
- ID platform and initial TCC lab test for NADEPJAX and CP
- Complete final lab testing of NI S-3 paint system
- Begin field testing of S-3 paint system
- STNP results for 509 revision

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Replacement of Cadmium for Landing Gear Internal Surface Coverage

BUDGET ACTIVITY: 6

PROGRAM ELEMENT: 0605854F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Funds target replacement of cadmium plating with Ion Vapor Deposition (IVD) aluminum on internal gear surfaces. Cadmium and the current plating process are highly toxic. Cadmium, a suspect carcinogen, is on the EPA 17 list of hazardous materials for reduction and removal from the workplace.

This technology was cooperatively funded by the Air Force, Navy (see p. D-59), and ESTCP in FY99 (see p. D-58).

ANNUAL PERFORMANCE OBJECTIVES FOR FY 99:

- Demonstrate and validate IVD; select candidate landing gear parts for plating internal surfaces

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Sodium Hydroxide Recycling System

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Sodium hydroxide is used to clean metal parts for plating and heat treatment processes. The U.S. Department of Defense, the U.S. Department of Energy, and private industry generate over 500,000 tons of sodium hydroxide waste per year. Sodium hydroxide is the largest volume waste substance generated at many of the Army Depots and Arsenals. This waste must be disposed of as hazardous waste. This project demonstrates new technologies that will reduce, reuse, and recycle sodium hydroxide to minimize hazardous waste emissions and production costs.

The project is simultaneously testing two competing, state-of-the-art production prototype sodium hydroxide recycling systems that recently became commercially available. This analysis will allow selection of the best technology based on cost, operational characteristics, and performance. The tests will be conducted on fluid in the heat treatment process and minor component plating areas. The recycling systems will be monitored for degradation of the cleaner and will replace required cleaning solution components that have been removed from the recycling systems. The first sodium hydroxide recycling system recovers the sodium hydroxide by using proven microfiltration mechanisms constructed with advanced, corrosion-resistant materials. The system's two membranes are ceramic and stainless steel, which have exhibited the best performance in caustic environments. The second system will recover rinse water from the primary sodium hydroxide soak tank and reuse it as a pre-rinse fluid. Using a pre-rinse fluid will remove oils and debris from the parts to be cleaned. This will extend bath life through elimination of the primary fouling agent in the sodium hydroxide bath. The chosen technology will then be fully demonstrated to provide long term operational and cost data.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete Membrane selection
- Complete System procurement
- Develop Tech-Demo plan
- Order Membrane
- Complete Delivery of Membranes
- Modify Piping and Electrical Systems
- Perform Acceptance Testing
- Complete Installation of Process Controller

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Tri-Service Demonstration/Validation of Chromium Electroplating Replacements

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The purpose of this project is to demonstrate and validate high-velocity oxygen-fuel (HVOF) thermal spray coatings and physical-vapor-deposited (PVD) coatings as alternatives to hard chrome plating at several U.S. Department of Defense (DoD) aviation maintenance depots.

Hard chrome plating is an essential repair and maintenance procedure for all military aircraft. Aircraft manufacturers also apply hard chrome to many components during the manufacturing process. Hard chrome plating uses hexavalent chromium (a chemical form of chromium found in chromic acid), which is a known carcinogen. The Occupational Safety and Health Administration proposes reducing the personal exposure limits for hexavalent chromium from the current 50 micrograms-per-cubic-meter to less than 1 microgram-per-cubic-meter. Such limits would shut down or impair chrome plating activities, seriously affecting military readiness. Also, decreasing budgets and longer life-cycle requirements on aircraft systems demand advanced coatings that will significantly reduce wear and corrosion, thereby decreasing the costs of operation and maintenance.

HVOF thermal spray and PVD coatings are used on a limited basis at a few military installations. This project represents a joint effort between DoD and the private sector to validate these coatings for a wide range of applications. HVOF systems will be installed at four air logistics centers and depots, and training will be provided by project members. The project will involve five tasks: (1) identify candidate aircraft components currently being plated with hard chrome; (2) determine optimum coating types and compositions; (3) establish and perform tests required to qualify the coatings; (4) install coated components on operational aircraft; and (5) document performance and cost savings. A technology transition plan will also be developed for use by any military installation that performs maintenance on aircraft as well as ships and ground vehicles.

This technology was cooperatively funded by the Air Force (see p. D-64), and the Navy (see p. D-65), and also with Canada in FY99.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Establish formal Project Agreement with Canadian Government
- Landing Gear - Complete draft Joint Test Protocol (JTP) and issue for approval
- Propeller Hub - Complete draft JTP and issue for approval
- Landing Gear - Publish final, approved JTP
- Landing Gear - Complete F-18 E/F main landing gear rig test at Boeing St. Louis
- Rotary Wing - Complete coupon testing

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Tri-Service Green Gun Barrel - PVD Technology for the Application of Environmentally Safe Coatings for Gun Barrel Bore Protection

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will develop an innovative dry (non-aqueous) process for the deposition of chromium or other materials equally suited to the bore protection of a gun barrel to replace the aqueous electrodeposition process. This novel process is called the Cylindrical Magnetron Sputtering Process (CMS). The project will result in an advanced technology demonstration addressing specific Army, Navy, and Air Force requirements in the plating of the Medium Caliber Barrels. Moreover, it will show that the work can be spun off to Large Caliber Gun Barrels and other applications including cylinders for recoiling mechanisms, aircraft landing gear, the oil processing industry, the power generation industry, and the mining and exploration industry.

CMS is a dry, environmentally clean technology capable of depositing chromium on gun tubes. It also has the flexibility to deposit other refractory metals and their alloys as well as being able to tailor the coating properties through the deposition thickness. Although the focus is on chromium, the deposition of alternate materials, such as tantalum, which will eliminate environmental problems as well as provide improved bore protection, will be evaluated. If chromium were deposited, environmental problems can still exist because a "consumable" chromium target would have to be made, most likely, by the same electrodeposition process that this project seeks to eliminate. Initial efforts will focus on developing the facility for investigating a single medium caliber size and the parameters required for depositing a well-adhered, uniformly-coated tubular section. Once established, the facility will be sized to accept the different caliber gun tubes provided by the tri-Service partners. These will be returned to the partners for firing tests. Leveraged support is through universities, other government agencies, and industries. Some of this support is through additional funds while other support is through exchange of services.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Evaluate sputtered coatings
- Plasma Process Development for 6 inch and M242 geometry
- Continue evaluation of sputtered coatings
- Complete Modified Design of Experiments
- Begin coating 55" long specimens
- Conduct commissioning tests for GAU-12 facility
- Fabricate and assemble GAU-12 sputter facility
- Commissioning tests for M242 facility
- Design fixtures for GAU-12 sputter facility
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

POLLUTION PREVENTION:
VOC AND HAP REDUCTION

PROJECT SUMMARY

TITLE: Applique as a Zero VOC Topcoat

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will: accelerate the collection of data on applique as a topcoat alternative to current paints by testing and measuring its performance in operational environments and perform Navy specific demonstrations and testing to meet naval aviation requirements.

This technology was cooperatively funded by the Navy and ESTCP in FY99 (see p. D-75).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- First material installation completed
- First flight; material failure
- Reinstallation completed
- Delivery to VS-32
- VS-32 AC first flight, material failure
- Second VS-32 test flight; continued material failure
- Aircraft transferred to VS-22. Failure analysis conducted. Aircraft stripped and repainted

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Applique Coatings Demonstration and Validation

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Current finishing systems used on Department of Defense (DoD) aircraft provide protection from environmental degradation as well as performing other functions. These systems are generally stripped and repainted every four to six years, an expensive process with considerable environmental impact. In addition, maintenance personnel must continually touch-up exterior finishes as they degrade from corrosion and weathering. One alternative to current systems is the use of protective films. Protective film technology has been used for specific applications in the aviation industry for many years: one of the primary means of protecting radomes and leading edges from rain-erosion is the use of elastomeric tapes - - flexible films bonded to painted surfaces with an attached adhesive. Manufacturers have developed appliqué films aimed at replacing aircraft exterior paints. Several on-going technology efforts investigating appliqué technology have demonstrated improved performance characteristics of appliqué as a topcoat on portions of aircraft under laboratory and short-term field conditions. Data from these programs will be used to address issues associated with fielding appliqué throughout DoD.

This multi-year joint service ESTCP appliqué effort will address and quantify application, removal, repair, maintenance, inspectability, and long-term reliability and cost results. Optimization of application, repair, maintenance, and removal procedures will be completed during laboratory and field demonstrations and validations. Data from this effort will be used for an efficient, cost-effective transition to existing legacy aircraft. This effort includes appliqué installation on DoD aircraft utilizing depot and field-level personnel and facilities; semi-annual evaluations of field maintenance and repair activities for periods up to six years; and removal and evaluation of aged appliqué material. Fourteen Air Force/Navy aircraft are proposed for the program; nine aircraft are currently funded through DoD or corporate sources. Lessons learned will be implemented on successive aircraft, and removal of the appliqué will occur at multiple intervals from 18 months to six years.

This technology was cooperatively funded by ESTCP, and the Navy in FY99 (see p. D-74).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Apply Applique to US Navy aircraft No. 1. S-3 and US Navy aircraft No. 2. S-3
- Develop Application Procedure KC-135
- Submit Final Demonstration/Test Plan to ESTCP
- Apply Applique to US Navy aircraft No. 3 E-2 (rotordome), US Navy aircraft No. 4 S-3, and US Navy aircraft No. 5 F/A-18
- Start depot demonstration on US Navy A/C #1
- Start depot demonstration at Tinker AFB
- Apply Applique to US Navy aircraft No. 6. F/A-18 and US Navy aircraft No. 7. S-3
- Start depot demonstration on US Navy A/C #2
- Monitor US Navy Aircraft No. 1 and 2 S-3 and S-3
- Apply applique material to USAF A/C #1 and to KC-135 A/C
- Submit Draft Final Report to ESTCP

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Aqueous Based Paint Coating and Stripping (Zippable Paints)

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0601102A

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop an aqueous-based system of paint coating and paint stripping. The coating and stripping will be carried out in a water phase to avoid the use of organic solvents.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Hexapeptides synthesized that have a high affinity for iron surfaces that can be thermally dissociated at temperature 150 °C when applied as a metal precoat beneath epoxy primers
- Successful demonstration of blowing agents (compounds that release nitrogen or carbon dioxide upon heating) for the thermal decomposition of surface coatings
- Showed evidence of topcoat decomposition by nanoparticle photocatalyst

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Automated Dry Dock Ship Painting Technology

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will develop technology to improve paint transfer efficiency and to capture paint over-spray to reduce air and water pollution that results from painting Navy ships in dry dock. The task will develop appropriate technologies for platform and nozzle positioning, paint over-spray containment and capture, waste processing, and sensing to provide efficient, automated paint application. Developed technologies will be integrated into a prototype device to demonstrate the automated painting of ship hulls.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete spray head and capture device dynamics analysis
- Design spray head and capture device and conduct laboratory testing
- Develop command and control algorithms
- Conduct paint characterization

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Control Technology for Depainting Operations

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602202F

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to decrease the cost, both in direct dollars and in hazardous exposure risks, associated with the application and removal of protective coatings on aircraft.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Determine relative concentration of hexavalent chromium particles in primer overspray as a function of particle size
- Determine bioavailability of hexavalent chromium particles in primer overspray as a function of drying time and particle size
- Explore one-cell pressure-swing adsorption/desorption method for recovery of volatile organic chemicals (VOCs) from exhaust air

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Demonstration/Validation of Zero-VOC Waterborne Polyurethane Topcoat

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Organic topcoats are the primary source of barrier-type protection against environmental degradation of Department of Defense (DoD) systems. Standard topcoats contain high levels of solvents and volatile organic compounds (VOCs). Since the painting process releases these VOCs as hazardous air pollutants (HAPs), current coatings create worker hazards and air pollution concerns for the facility. Hazardous waste disposal is also a problem. A single Navy Depot typically discharges over 15,000 pounds of solvent per year from coating operations. This project demonstrates and validates the performance of a waterborne, polyurethane topcoat that does not contain solvents or VOCs.

The new waterborne polyurethane topcoat formulation builds on recent advances in polymer chemistry. The resins used in the new topcoats are water-dispersible and do not require organic solvents for viscosity reduction and spray application. Standard topcoats use solvents to coalesce binders and pigments into a continuous coating. In waterborne, polyurethane topcoats, the polymer exists in an organic phase surrounded by water which, instead of a solvent, provides the necessary liquid medium. After application, the water evaporates and allows the binder and pigment particles to fuse into a continuous film.

This technology was cooperatively funded by the ESTCP and the Navy in FY99 (see p. D-99).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Coordinate demonstration schedules
- Final demonstration plan approved
- Begin demonstration at first site
- Begin demonstration at second site
- Conduct first quarterly inspection at all sites
- Complete Joint Test Protocol
- Conduct second quarterly inspection at all sites
- Begin specification revisions
- Conduct third quarterly inspection at all sites

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Flashjet Gantry Qualification/Certification

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to qualify the Flashjet technology for use on Composite Materials and Rotary Wing Aircraft.

This technology is cooperatively funded by the Navy and ESTCP (see p. D-97).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- F/A-18E/F required acoustic vibration tests completed
- Materials and structures review of test results on fixed wing composites and final approval
- Phase I high cycle fatigue tests to support one-time depaint of H-60 (rotary wing)

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Improved Chemical Agent Resistant Coating (CARC) Systems and Techniques

BUDGET ACTIVITY: 2 & 4

PROGRAM ELEMENT: 0602105A

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will develop, prove, and implement an improved CARC system containing neither hazardous air pollutants (HAPs) nor hazardous pretreatment systems as well as lower weapons systems life cycles costs and improve readiness through improved coating system performance and minimization of VOC compliance requirements (reporting and waste generation). This project will pursue the following elements:

- Army Research Laboratory partnership with commercial coatings suppliers.
- Develop HAPs-free/non-hazardous coatings technologies with CARC characteristics.
- Evaluate products and pre-treatments as part of a total CARC system.
- Transition coatings technologies to user community.

Reduction or elimination of VOCs and HAPs in CARC systems allows depots to maintain compliance with the CAA and the Miscellaneous Metal and Plastics Coatings NESHAP while meeting operational levels as identified under Army requirements.

This project was cooperatively funded by SERDP in FY99 (see p. D-82).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

All but one of the existing CARC surface treatments, primers and topcoats shall contain VOC levels within compliance of the Miscellaneous Metal & Plastics Coatings National Environmental Standards for HAP (NESHAP).

ANNUAL PERFORMANCE REVIEW: Met all performance objectives for FY99.

PROJECT SUMMARY

TITLE: Low VOC Chemical Agent Resistant Coating (CARC)

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project developed a low volatile organic compound (VOC) Chemical Agent Resistant Coating (CARC) system suitable for use on military equipment in which the materials and processes for the reformulation/application, stripping, and disposal are optimized and in compliance with current and anticipated regulatory requirements. The primary focus was to reduce the VOC of the polyurethane topcoat from 3.5 lb/gal to 1.8 lb/gal. Additionally, this CARC will eliminate the hazardous air pollutants (HAPs) and toxic solvents used in the current topcoat formulation.

This project was cooperatively funded by SERDP and the Army in FY99 (see p. D-81).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Establish compatibility of CARC to substrate preparation
- Initiate field testing
- Complete pilot plant production of all 5 colors
- Establish compatibility of CARC with primers
- Conduct Design of Experiments (DOE) on film performance
- Evaluate application parameters of pilot plant manufactured coatings
- Test optimum systems/application processes
- Establish production requirements and surface finish constraints
- Perform stripping process development/modification studies
- Complete Final Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Low VOC, Non-Chromated Adhesive Bonding

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objectives of this project are to: (1) evaluate BR6747-1 primer for system properties (adhesive and primer) in bonded repair and OEM scenarios and ensure that there is no decrease in adhesive bond integrity of system, and (2) evaluate compliant sol-gel surface preparation for aluminum, titanium, and stainless steel alloys as a part of a system that also utilizes zero VOC adhesive bond primers and recommend implementation to OEM where applicable.

This technology was cooperatively funded by the Navy, the Air Force (see p. D-61), and SERDP (see p. D-94) in FY99.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Coordinate effort with 4.3.4 establish test parameters
- Establish EA6-B parts to be bonded
- Complete ASTM-D-1002 CSD and SSD testing
- Brief F-18E/F Green Hornet IPT
- Coordinate results with F/A-18 E/F Green Hornet
- Establish SH-60B parts to be bonded
- Conduct fatigue test with bonded patch
- Conduct field demonstration of Type II SH-60B bonded repair parts

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Non-Chromated, Non-HAPs Sealant

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to evaluate PR-1875 for application and corrosion protection properties as well as compatibility with aircraft fluids and adhesion to available primers and topcoats. Ensure no compromise of sealant requirements occurs. Recommend implementation to OEM to reduce chromated waste stream for the fleet. Evaluate Skyflex on access panels, windshields, and floorboards of all Navy aircraft. Generate standard application criteria but also focus on platform-unique applications. Recommend implementation to OEM to reduce fleet costs.

This technology was cooperatively funded by the Navy and SERDP in FY99 (see p. D-93).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

PR-1875

- Obtained Courtaulds results of primer compatibility study
- Obtained new materials and restarted tests
- Courtaulds pulled PR-1875 from production plans
- Generated new test plan to evaluate need for corrosion-inhibiting additives
- Obtain materials and start new corrosion test

Skyflex

- Trial installations and evaluation periods (non-fuel, non-pressurized panels) on F/A-18 C/D, E-6A, H-53 (fuselage panels), C-130 (fuselage panels), and T-45 (fuselage and fuel panels)
- Approved fluid resistant adhesive for greater application flexibility
- Fleetwide approval on AH-1/UH-1 (non-fuel panels)
- Trial installation and evaluation period (windscreen) on P-3 and C-130
- Fleetwide approval on H-60 (non-fuel panels)
- Added Skyflex to NA 01-1A-509 manual
- Recommend fleetwide approval (all platforms): (1) access panels (pressurized and non-pressurized, fuel and non-fuel) and (2) floorboards

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Non-HAPs Chemical Strippers**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The objective of this project is to develop and test new formulations of non-HAPS paint removers that are more effective will spur the move to significantly reduce the use of HAPS removers. Perform hydrogen embrittlement tests with the RSL machine on various non-HAPS products to develop a method and standard practice. Additionally to qualify new products for transition and review and revise the TT-R-2918 specification. These materials will be tested, validated, and certified to naval aviation requirements.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Depot Field Tests
- New NSN assignments
- TT-R-2918 Amendment

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Non-HAPs Paint Purge Solvent**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The objective of this project is to formulate, develop, and test a HAP-free, low vapor pressure solvent blend for cleaning organic spray equipment. Federal specifications covering the requirements of such material will be updated and included in the NA01-1A-509 general series corrosion control manual and the Air Force's T.O.1-1-8. The specification should include two functional types addressing (1) the cleaning and purging of the spray equipment; and (2) thinning of high solids aerospace paints without incurring into adding VOC to the final paint. This material will be demonstrated and certified to satisfy naval aviation requirements.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Up-date submitted specification to include paint thinning requirements
- Identify Non-HAPs and VOC free materials to be included in previously submitted specification
- Generate draft performance specification
- Submit final report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Non-HAPs Prepaint Cleaner**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: Shipboard maintenance hangars do not have floor drains to allow water rinsing of detergent cleaners. Therefore, MEK and MEK-containing materials have been the preferred solvent for wipe-solvent applications prior to bonding and painting for many years. These materials are now restricted by the 1998 NESHAP. The goal of this project is to develop and test alternative solvent materials. A mixture of acetone with other solvents is a promising candidate. Acetone is not a Hazardous Air Pollutant or a Volatile Organic Compound, therefore, this project will demonstrate an acetone solvent mixture and a semi-aqueous solvent. These materials will be certified and transitioned to the fleet.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Initial (Phase I) prototype of acetone solvent mixture
- Advanced (Phase II) prototype of semi-aqueous material
- Modifications of acetone solvent mixture
- Develop requirements for semi-aqueous material
- Advanced (Phase II) prototype of semi-aqueous material
- Develop requirements for acetone solvent mixture
- Complete modified specification for new materials

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Non-HAPs Sealant Thinner**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The objective of this project is to eliminate the need for using MEK and toluene (HAPs) for thinning and cleaning MIL-S-81733, type III by formulating, developing, and evaluating HAP-free solvent blends for thinning MIL-S-81733, type III and cleaning spray paint equipment contaminated with subject material. These materials will be validated and certified to naval aviation requirements.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Establish solubility parameters of polysulfide resins
- Assess physical and performance characteristics
- Establish solubility parameters of potential HAP-free solvent mixtures
- Test dilutability performance of new blends
- Study and compare rheological properties of diluted sealants
- Narrow down solvent blends

ANNUAL PERFORMANCE REVIEW: Met performance objectives.

PROJECT SUMMARY

TITLE: Non-Structural Adhesives Requiring No VOCs

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Polymeric adhesives are used in variety of joining applications in the military and civilian sectors. Military applications of adhesives include universal rotor blade pockets, thermoplastic insulation, and standoffs in electronic cabinets and in bonded joints. Adhesives currently used contain epoxy-polyamides, polyurethane, polysulfides, or alpha-cyanoacrylates. Adhesives also require toxic volatile organic compounds (VOCs) to polymerize, and therefore posing significant environmental and health hazards. Based on the Toxic Release Inventory information, it is estimated that 172,800 pounds of VOCs are released annually through the use of solvent based adhesives. About 50 to 75 percent of this quantity is released into the environment. The objective of this project is to develop innovative, compliant adhesive polymers that have no requirement for volatile organic compounds. The source of these polymers will be microorganisms isolated from high temperature waters. Extracellular polymers produced by novel microorganisms called extremophiles isolated from natural hot springs will be examined for non-structural adhesive properties. A two-phased approach will be applied toward the analysis and development of these novel polymer adhesives: 1) screening new polymers using standard physical performance tests of adhesive properties; and 2) detailed analysis which will lead to the formation of derivative compounds with expanded capabilities. Analytical techniques will include infrared and mass spectrometry, and genetic engineering of cloned adhesive peptides.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop and utilize purification techniques to derive polymers from the microbial cultures grown
- Culture first lot of 2000 pre-selected microorganisms
- Purify polymers from the first lot of 200 microbial extracts that have demonstrated significant adhesive properties
- Identify new microorganisms that produce unrefined adhesives that demonstrate flatwise tension strength with aluminum 2024 of at least 8 psi.
- Identify microorganism(s) within the first lot of 200 isolates that produce unrefined extracts containing adhesives that demonstrate flatwise tension strength with aluminum 2024 of at least 10 psi as determined by Instron analysis
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: On-Board Oxygen Line Cleaning System for Use with DoD Weapons Systems

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST IEM? No.

DESCRIPTION: Weapons systems in use by Department of Defense (DoD) have several types of oxygen supply systems, all of which eventually develop contamination in the distribution system. These distribution systems require maintenance, periodic cleaning and emergency cleaning. Maintaining a clean environment in oxygen systems is a critical requirement. Contaminant buildup decreases system performance, increases demand on maintenance resources and prematurely removes the aircraft from mission support. The purpose of this project is to develop and validate a Prototype Oxygen Line Cleaning System (POLCS). This system is to replace the expensive, time consuming and environmentally unfriendly current process that consists of plumbing disassembly with chemical cleaning of individual components. The POLCS is to perform cleaning of contaminated aircraft systems without disassembly and with environmentally acceptable materials.

This project involves the development of a cleaning process that will allow the entire oxygen system on DoD aircraft to be cleaned without removal of significant components or disassembly of the aircraft oxygen plumbing. A suitable process to accomplish this goal does not exist at this time. Currently, when an aircraft system is contaminated, the system is broken down into basic components, the components are cleaned (often with FREON or other compounds) and protected, the system is then reassembled with an attempt made to avoid re-contamination of the components or system. These maintenance actions result in excessive costs, use of unacceptable chemicals, aircraft down time and risk of creating leaks or damaging the equipment. There are very specialized problems when cleaning oxygen equipment or lines. All particulates must be removed to improve system reliability, all hydrocarbons must be removed to minimize risk of fire and all cleaning materials must be removed to minimize risk of crew exposure. This program will determine whether these goals can be accomplished and demonstrate that capability. Judicious chemical selection and minimizing chemical waste is also at the core of this program.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Prepare draft demo plan
- Complete identification of major components
- Complete identification of sensor and analytical equipment
- Complete system design
- Complete 65% design review
- Complete component identification and ordering
- Complete develop control and support software

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Primerless RTV Silicone Sealants/Adhesives

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Room temperature vulcanizing (RTV) silicones, developed in the late 1940's, have played an important role in the design and superior performance of weapon systems (airplanes, missiles, electronics, ammunition, vehicles and nuclear weapons) developed by the DoD and DOE. A unique combination of properties has made them the material of choice for designers wanting to improve and increase weapon performance. RTV silicones are used as adhesives, sealants, coatings, heat insulators and encapsulating materials. For RTV silicones to achieve a high level of consistent adhesion to various substrates, a saline primer is applied prior to silicone application. These primers contain 90-98% volatile organic compound (VOC) solvents, which evaporate into the air. The objective of this project is to develop, evaluate, and transition a primerless self-bonding low temperature curable addition cured silicone, which eliminates the use of high VOC primers without compromising durability, compatibility, thermal resistance and long term stability.

The project will be conducted in four phases. In phase I, current addition cured silicones available off the shelf will be modified with a bifunctional adhesion promoter compound. In phase II, a less inhibiting adhesion promoter, based on structures defined by molecular modeling will be utilized in an attempt to develop room temperature curing systems. Laboratory adhesion evaluations will be used to establish "go/no go" criteria for technology development in phase II. To expand adhesion capability to a variety of substrate materials, including plastics, novel adhesion promoting concepts will be evaluated in phase III using guidance from molecular modeling predictions. Phase IV will demonstrate the use of a new primerless silicone formulation.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Evaluate Current Technology
- Complete Baseline Adhesion Studies
- Test 1st Generation Product
- Develop Molecular Modeling - 1st Generation
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Recycle and Reuse of Industrial Rags Using Liquid CO₂ and Surfactant Additives as a Cleaning Agent

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The technical objectives of this proposal are to develop, demonstrate, and evaluate a liquid CO₂ (LCO₂) fabric cleaning technology for application to the cleaning of DoD generated hazardous cleaning rags. The most promising candidate technology to accomplish this objective is the use of liquid CO₂ (LCO₂) with surfactant additives.

The major objective during the program is to conduct and complete research to design and synthesize LCO₂ compatible amphiphilic surfactants. The surfactants have a micelle-forming capability to emulsify lipophilic contaminants within a continuous LCO₂ phase. These surfactant systems must be applicable to a broad range of contaminants which will be defined by the potential users.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop comprehensive test protocol for system efficiency evaluation
- Complete rag and contaminant identification and characterization
- Complete laboratory testing of candidate surfactants
- Complete candidate surfactant synthesis and tailoring
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Project was terminated due to lack of technical progress.

PROJECT SUMMARY

TITLE: Replacement Non-Toxic Sealants for Standard Chromated Sealants

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this work is to formulate and test candidate non-chromated sealants that will provide equivalent or improved properties as compared to the existing chromated sealants while meeting the requirements of MIL-S-81733C. Additional goal is to reduce the volatile organic compound (VOC) content of the materials by 65 percent.

Sealants are required in aircraft systems and on weapons to provide protection against corrosion, prevent moisture entry, provide a fuel barrier, and provide electrical insulation. Traditionally, sealants use chromium as the primary corrosion inhibiting substance. Chromium has been designated as hazardous and is targeted for elimination in order to comply with either current or pending Occupational Safety and Health Administration (OSHA) requirements. Most sealants also contain VOCs such as methyl ethyl ketone (MEK) and toluene. Under this project team's guidance, a chromate-free corrosion inhibiting sealant has been developed, tested and transitioned to the field. A new polymer has been developed that is characterized by properties beneficial to corrosion-inhibiting sealants: rapid cure times without a reduction in work life; a pleasant odor; excellent rheological properties; excellent cure at low temperatures; and high solvent resistance. The proposed work is directed towards use of this new polymer to formulate corrosion inhibiting sealants for all the types and classes of MIL-S-81733.

This technology was cooperatively funded by SERDP and the Navy in FY99 (see p. D-84).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Identify corrosion inhibiting compounds to be used with polymers selected
- Accomplish lab property determinations
- Complete preliminary computer subroutines for estimation of new solvent performance requirements
- Begin formulation process for each type and class of sealant
- Complete preliminary property estimation models for the required solvent properties, if not already present in the current version of PARIS, and incorporate in the program
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Sol-Gel Technology for Low VOC, Non-Chromated Adhesive and Sealant Applications

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: State-of-the art metal surface preparations for adhesive bonding mainly consist of anodization or etching processes using strong acids. Many of these also contain hexavalent chromium. The surface treatment is followed by application of a corrosion-inhibiting adhesive primer that typically contains high VOC levels and hexavalent chromium. Cytec BR 127 is the industry standard adhesive primer for most applications; it contains approximately 780 grams/liter VOC and strontium chromate at 10-12% of the total solids weight. Adhesion promoters and primers used to prepare metal and composite surfaces for sealant application also contain high levels of VOCs. The technical objective of this project is to develop, and transition to DoD and other organizations, processes that eliminate the VOCs, chromates, and strong acids typically found in the metal surface treatment and priming steps conducted prior to the application of adhesives and/or sealants. Secondary objectives are the reduction of hazardous wastewater streams associated with current processes and improved performance compared to these processes. This project will build on recent work using non-chromated, zero-VOC, sol-gel technology to deposit thin organic-inorganic coatings on metal surfaces in order to develop good adhesion between the metal and subsequently applied polymers (primer, adhesive, or sealant) via covalent chemical bonding. This project consists of four tasks: three adhesive bonding tasks and a sealant adhesion promoter/primer task. The adhesive bonding tasks include: 1) optimization and transition of a sol-gel surface preparation(s) for aluminum, titanium, and steel, 2) development of a sol-gel/primer mix that eliminates the separate priming step, 3) test/evaluation of non-chromated, zero-VOC, sol-gel/primer mix to replace existing primers used with the current phosphoric acid anodize (PAA) surface preparation for aluminum and, 4) sol-gel technology for sealant adhesion promoters/primers.

This technology was cooperatively funded by SERDP, the Navy (see p. D-83), and the Air Force (see p. D-61) in FY99.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop models for the effects of surface activation on sol-gel attachment sites and correlate with test data
- Develop general depot-level processing procedures
- Complete characterization of titanium surfaces
- Downselect initial hybrid resin chemistries and formulation chemistries for steel
- Develop models of interactions between sol-gel structures and metal surfaces
- Determine sol-gel feasibility for targeted sealants
- Optimize grit blast on-aircraft application for titanium
- Optimize aluminum application processes
- Complete initial evaluations of one-step primers with PAA
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Supercritical Fluid Spray Application Process for Adhesives and Primers

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop or identify low/no-VOC (volatile organic compound), non-structural adhesives to substitute for the current high-VOC, non-structural adhesives used in military applications. It is estimated that 8.5 billion pounds of synthetic polymer adhesives are used annually, of which approximately 55 percent are VOCs. While the total DoD usage is not known, it is estimated that approximately 173,000 pounds of VOCs are released annually by Air Force aircraft operations. VOCs commonly used in applying adhesives include aromatics (e.g., toluene), ketones (e.g., acetone, methyl ethyl ketone), and others (e.g., methanol, chloroform) which negatively impact worker health and safety, adversely affect environmental standards, are ozone depleting, and result in increased hazardous material management costs including permitting and installation of sophisticated emission control equipment.

Conceptually, the UNICARB process is straightforward in that a concentrated solution of polymeric material (in this case the adhesive and adhesive primers), and other additives are mixed in situ with high-pressure (in the range of 1000 psi to 2000 psi) carbon dioxide and then sprayed. In practice, the process is complicated in that one is mixing an incompressible, highly viscous material (polymeric material and solvents) with a highly compressible fluid of very low viscosity (supercritical carbon dioxide). The solvents are mixtures of fast and slow evaporating VOCs which are chosen specifically for their ability to dissolve the polymeric material, reduce viscosity, and aid in atomization and droplet coalescence on the substrate. In the supercritical spray process, supercritical carbon dioxide replaces that fraction of the organic solvent that is needed to give the viscosity reduction necessary for spray atomization. This is also the solvent that is the primary contributor to the high VOC emissions.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Selection of an adhesive system to be investigated and identification of solvent and polymer constituents
- Perform phase behavior experiments
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Trapped Vortex Combustor for Jet Engines

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This project will provide the design basis to demonstrate the capability of a trapped vortex combustor (TVC) to reduce pollutant emissions and conserve fuel. The TVC technology is proposed for use in aircraft and in stationary gas turbine engines used on naval vessels. The goals of this project are to demonstrate the feasibility of developing a TVC that will: (1) reduce aircraft pollutant emissions [nitrogen oxides (NO_x), volatile organic compounds (VOCs), CO, and particulate matter (PM)-10] by 60 percent, bringing them significantly below the proposed 1996 Environmental Protection Agency (EPA) regulations; and (2) reduce NO_x emissions from a stationary gas turbine by 60 percent, bringing these NO_x emissions below the California Resource Board recommendation of 42 ppm and the 1995 EPA regulation for land and marine (L&M) based gas turbine engines burning distillate fuels. A 3% decrease in specific fuel consumption (the fuel mass flow rate required to generate a unit of thrust) is also expected.

The project will develop an optimized trapped vortex design for use in the General Electric (GE) Integrated High Performance Turbine Engine Technology (IHPTET) Phase III prototype gas turbine engine and will evaluate the use of a TVC in stationary gas turbine engines on Naval vessels. Three parts are required to make this new combustor system: a new integrated fuel injector/diffuser, TVC section, and thermal management system. GE will design and test the integrated diffuser and thermal management system. GE and Air Force Research Laboratory (AFRL) will work together to design and incorporate the low emissions TVC portion and will incorporate all three efforts into a final design. The technical approach uses a combined Computational Fluid Dynamics (CFD) design study with an experimental sector rig study to investigate different TV configuration at realistic conditions and with realistic size combustors. TVCs with three different missions will be investigated. The first mission corresponds to a future high performance aircraft that would utilize IHPTET engine technology. The second mission corresponds to that of a conventional aircraft. This mission is included to provide the Air Force with the option of upgrading existing engines to a low emissions, fuel efficient TVC in the future. The third mission corresponds to possible future forward-fit for new purchases of Land/Marine (LM) 2500 engines used aboard Naval vessels.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Design Optimized Lox NO_x L&M TVC Sector
- Evaluate L&M 12" TVC Sector
- Evaluate Configuration 3 - Tri-Pass, Single Vortex 12" Sector
- Evaluate Configuration 4 - Bi-Pass, Single Vortex 12" Sector
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Tri-Service Demonstration/Validation of the Pulsed Optical Energy Decoating (FLASHJET) Process for Military Applications

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603851D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: In 1994, traditional depainting processes generated approximately 2.5 million pounds, or 20 percent, of all reportable waste produced by U.S. Department of Defense (DoD) operations. The need to identify less wasteful depainting methods is driven by high waste disposal costs and Executive Order 12856, which requires installations to reduce off-site waste treatment or disposal by 50 percent. The purpose of this project is to demonstrate and validate that the FLASHJET® coatings removal technology greatly reduces the volume of hazardous waste produced and reduces worker exposure to hazardous materials. The FLASHJET® process combines a xenon-flashlamp with low pressure carbon dioxide (dry ice) pellet blasting. The xenon-flashlamp ablates the coating from the substrate and the dry ice pellets cool and clean the substrate and sweep the coating into an effluent capture system. The effluent capture system vacuums the by-product dust through a series of air pollution control equipment including High Efficiency Particulate Air (HEPA) filters. These filters leave the air clean enough for venting to the atmosphere.

The U.S. Navy has recently approved the FLASHJET® process for metallic, fixed-wing aircraft. This project will evaluate the FLASHJET® process on U.S. Navy and U.S. Air Force rotary-wing aircraft and off-aircraft components. In conjunction with the rotary wing demonstration, the U.S. Navy and the U.S. Air Force will conduct a helicopter high-cycle fatigue testing program for parts decoated with this process. After aircraft testing is complete, the U.S. Army would consider evaluating the FLASHJET® process for use on its ground vehicles.

This technology was cooperatively funded by ESTCP and the Navy in FY99 (see p. D-80).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete Phase Ia of the FLASHJET Qualification Testing Program at Patuxent River Naval Air Station's Mechanical Engineering Laboratory
- Complete the CH-53 Off Aircraft Components demonstration in St. Louis, MO
- Complete Phase Ib of the FLASHJET Qualification Testing Program at Patuxent River Naval Air Station, MD
- Award The Boeing Company's Option Year contract
- Begin Phase Ic of the FLASHJET Qualification Testing Program
- Complete Phase II of the FLASHJET Qualification Testing Program

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Welding Fume Emissions Reduction**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The objective of this project is to minimize airborne emissions of chromium, as well as manganese and nickel, in Navy construction and repair welding in order to comply with OSHA and EPA requirements. OSHA permissible exposure limits (PELs) for hexavalent chromium are anticipated to be reduced from 100 ug/m³ to 0.5 ug/m³ in 1999. Non-compliance with manganese, nickel and copper levels has been found in Navy shipyard fabrication. State environmental air toxic regulations, now in about 42 states, impose fenceline HAP limits based on OSHA PELs. Proposed reductions in PELs for hexavalent chromium, manganese, nickel, and copper will impact compliance with these EPA fenceline limits.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Evaluate High Vacuum Hoods
- Evaluate Arc Gouging for Welding
- Evaluate Inverter Welding Power Supplies
- Evaluate Lower Fume Filler Metals
- Recommended alternatives must meet proposed PEL standards for chromium

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Zero VOC Topcoats**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The zero-VOC topcoat is an environmentally friendly replacement for MIL-PRF-85285, the high-solids polyurethane aircraft topcoat. This topcoat has the potential to eliminate up to 120 TONS of organic solvent from coatings applications DoD-wide. Successful implementation will eliminate the need for expensive pollution abatement equipment while maintaining the high performance properties of standard aerospace topcoats. This topcoat will be certified to naval aviation requirements.

This technology was cooperatively funded by the Navy and ESTCP in FY99 (see p. D-79).

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Complete Joint Test Protocol for zero VOC topcoats
- Issue first draft Joint Test Report to Stakeholders
- Begin demo at first Navy site
- Conduct first quarterly inspection

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Flashjet Mobile Manipulator**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** Yes.

DESCRIPTION: Complete the design and integration of the flash head onto a mobile manipulator for depainting large P-3 Orion aircraft which cannot be processed in a gantry system and which provides reasonable production benefits in turn around time (TAT) and cost. This project will transition the new concept mobile lift platform developed during Phase I and II during FY00 into a production viable flash jet paint removal system in FY 01and FY 02. Further investment in the manipulator depends on the success this year. During FY01, this project will facilitate and manage the successful installation, demonstration, and acceptance test of the new concept mobile FlashJet Paint Removal System for P-3 Orion aircraft at NADEP Jacksonville (Phase III). During FY02, this project will develop and execute the final transition plan for mobile manipulator technology to the production level (Phase IV). Additionally, this project will facilitate and manage the successful installation, demonstration and test of an advanced coating/demilitarization of metal parts technology and/or metal recycling techniques.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Develop SOO/SOW/Specification
- Contract Award

ANNUAL PERFORMANCE REVIEW: Did not achieve contract award in FY99.

POLLUTION PREVENTION:

OTHER

PROJECT SUMMARY

TITLE: A Cleaning Verification Technique Based on Infrared Optical Methods

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop a real-time method to provide both qualitative and quantitative assessments of surface cleanliness for a wide variety of military cleaning applications. The introduction of new environmentally acceptable solvents for traditional chlorinated hydrocarbon materials has produce major uncertainties in standard cleaning procedures. As a result, many applications over-utilize solvents to ensure component cleanliness and the success of any subsequent processing operations (such as coating or bonding). This, in turn, leads to the additional usage, handling and disposal of hazardous materials, while also wasting personnel operating time. This project will develop two prototype infrared-optical instruments with complementary capabilities for use at DoD sites that will reduce the use, emission and handling of hazardous materials in cleaning operations, and will also be applicable to DOE and commercial sector needs.

Currently, the detection of surface contamination on reflective surfaces is most convenient and rapidly done by the Fourier Transform Infrared (FTIR) reflectance method which provides both quantitative and qualitative information on surface coatings. However, it is greatly limited in its ultimate sensitivity to surface contaminants by the nature of its optical design. In this program, surface contamination will be detected via alteration of the grazing-incidence infrared reflectance of the surface. Specifically, the project will: 1) develop a prototype on-line widely tunable infrared laser based instrument with high speed surface-imaging capability but with limitations on the number of detectable organic contaminants; and 2) optimize an FTIR based instrument with high sensitivity for organic species on a variety of surfaces, but with limitations on speed and surface coverage for real-time analysis of surface contaminants at very low level concentrations. The proposed instruments will differ in the nature of the information they provide. The first will produce images that directly indicate the spatial extent and location of contamination. The second will provide a spectrally-resolved measurement of the surface reflectance at a single point.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Evaluate sensitivity to hydrocarbon contaminants
- Demonstrate contaminant detection method
- Evaluate sensitivity to generic contaminants
- Construct FTIR optical interface
- Construct IR-Laser optical interface
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** ALRE Source Reduction**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: Due to the design of the catapult and its integration with the ship the petroleum products are directly discharged into the waters where the ship is operating. This discharge of petroleum products has recently received much environmental scrutiny. The goal of this project is to replace the current petroleum product with an environmentally friendly lubricant and minimize the discharge with material substitutions, hardware modification and fleet management practices.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Weight tolerance study
- Finalize materials selection
- Engineering support
- Design analysis and drawings

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Alternative Countermeasure Materials

BUDGET ACTIVITY: 4

PROGRAM ELEMENT: 0603721N

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: This objective of this project is to provide environmentally safe degradable chaff along with end-caps, pistons, and case made with Degradable Materials for the RR-144A/AL chaff countermeasures. This will ensure that our aircrews can continue to train for combat readiness with Chaff countermeasures.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Chaff Dipole inhalation study; Sediment/soil tests Chesapeake Bay, MD
- Received samples of half-coat degradable chaff
- Combined tests with EcoChaff™, standard chaff
- First delivery 840 RR-144A half coat degradable chaff
- Forwarded 480 RR-144A and 480 RR-144 to China Lake VX-9 and 240 RR-144A and 240 RR-144 to NAS, Fallon for cooperative comparison Developmental test (DT).
- Procure additional RR-144A half coat degradable chaff; Report from NHRI on physiologically-based extraction test

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Cermet Coatings**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The objective of this project is to assess properties of ceramic metallic coating for replacement of cadmium plating on aircraft steel parts. These materials will be processed, tested, and certified for naval aviation systems use.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Negotiate process costs and coupons manufacture
- Coupon testing JG-PP Joint Test Protocol and other

ANNUAL PERFORMANCE REVIEW: Project cancelled due to materials deficiencies.

PROJECT SUMMARY**TITLE:** CO₂ Retrofit of Aircraft Portable Fire Extinguishers**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The objective of this project is to reduce the amount of ODS being discharged to ambient, the Navy plans to replace Halon 1301 portable extinguishers with CO₂ which has a zero ozone depleting potential. Therefore, there is a need to qualify a manufacturer for the new CO₂ PFE assembly and transition it to the fleet; therefore, reducing the emissions of ODS during fire fighting training and aircraft emergency procedures. This project tests the bottle and bracketing design to naval aviation flight safety and durability standards (vibration, gun fire, temperature, fatigue) and certifies the design for implementation to naval aircraft.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Delivery of First Article Test Report
- Low rate initial production
- Full production
- Bottle availability

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Development of Innovative Nondestructive Evaluation Technologies for the Inspection of Cracking and Corrosion under Coatings

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The objective of this project is to develop and evaluate three technologies for their viability as nondestructive evaluation (NDE) tools for the detection of cracks and corrosion under surface coatings in aircraft and ground vehicle applications. They have been developed in the private sector under either private or SBIR program funding and have shown promise for meeting the technical and sometimes unique logistical needs of DoD aircraft and ground vehicle applications. These technologies include: 1) Ultrasound Imaging, 2) Thermal Imaging, and 3) Near-Field Microwave Imaging. These technologies were proposed for investigation based on their potential to inspect areas rather than points (translating into efficient levels of inspection scan rates), portability to the job site, overall projected economy to implement, and relative technology maturity. Two of the techniques, Ultrasound and Microwave Imaging, are believed to be effective in detecting cracks under coatings and will be investigated for that purpose, as well. In parallel to NDE techniques development, models will be developed to correlate with the output signature of these various techniques. Electrochemical Impedance Spectroscopy (EIS) will be used to validate the measurements. Finally, a “round robin” test will be performed to determine the most effective NDE technique for detecting corrosion.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Modeling Complete
- Evaluation sample design selection
- Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Mechanisms of Military Coatings Degradation**BUDGET ACTIVITY:** 3**PROGRAM ELEMENT:** 0603716D**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: Military coating systems are usually repainted for the following reasons: loss of appearance (aesthetics, camouflage, cleanliness); chipping, peeling, debonding of the coating; and corrosion of the substrate. The primary technical objective of this project is to identify, model, and predict degradation mechanisms that lead to military coating system failures and force depaint/paint operations to occur. An overall deliverable of the proposed effort would be pollution prevention via intelligent reduction of the paint/repaint frequency. The project will develop models of coating degradation and provide a scientific basis to develop new durable coating formulations that will help to achieve this goal. The research findings will be transitioned through appropriate vehicles to the Army, Navy, Air Force, and Marine Corps. The outcome of this program will have a positive impact on both pollution prevention and cost avoidance to the Department of Defense.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Coordinate selection, coating, and fielding of military assets for dynamic field aging
- Initiate Artificial Aging
- Complete preliminary baseline characterization
- Select and acquire primers, coatings, and panels
- Review, assess, and catalogue existing data
- Formulate tagged coatings: initiate synchrotron IR microspectroscopy
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Nondestructive Testing of Corrosion under Coatings

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: Surface corrosion on aluminum aircraft skins and around joints and fasteners is often the precursor to buried corrosion. Aircraft paints are routinely removed to inspect for the presence of corrosion on the surface of metal structures and the aircraft is subsequently repainted. Aircraft painting and repainting operations result in significant emissions of volatile organics, organic and inorganic hazardous air pollutants, and hazardous waste. The objective of this project is to develop nondestructive inspection techniques to detect the presence of corrosion under an organic film in order to reduce the amount of painting and depainting that is performed. This project will develop: 1) a spectral NDE technique employing an optical reflectance probe in the near/mid IR region combined with Directional Hemispherical Reflectance (DHR) and FTIR integrated detector; 2) Wide-area spectral imaging (WASI) using spectral filters and high-resolution focal plane cameras to allow rapid initial assessment of sub-paint corrosion; and 3) a Scanning Kelvin Probe (SKP) electrochemical method employing a calibrated capacitance probe to indirectly measure corrosion potential across a surface. Challenges to be overcome include probe positioning and electrical noise.

The project consists of five tasks over four years: 1) baseline measurements of unexposed coatings and typical corrosion products to build up a database of standards; 2) evaluation of aged aircraft components; 3) optimization of measuring systems at varying levels of corrosion and their modification for field use; 4) prototype verification (in conjunction with NAWCAD); and 5) preparation of a transition plan for cost-effective applications.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Prepared specimens
- Obtained hardware & conduct preliminary evaluation
- Completed Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY**TITLE:** Paint Dehydration**BUDGET ACTIVITY:** 4**PROGRAM ELEMENT:** 0603721N**IS THIS A CONGRESSIONAL INTEREST ITEM?** No.

DESCRIPTION: The objective of this project was to develop, optimize, and field demonstrate a prototypic solar paint dehydrator system to dewater left-over latex paint for the purpose of reducing disposal volume and disposal cost at Navy and Marine Corps PWCs. Large volumes of water-based (WB) paint wastes are generated from paint operations at Navy and Marine Corps bases. Paint cans that are opened, however, are routinely turned over to disposal contractors and disposed as hazardous waste. Removal of the water fraction from WB paint would reduce the volume and potentially reduce the disposal costs.

ANNUAL PERFORMANCE OBJECTIVE FOR FY99:

- Optimize prototype design
- Select site for field demonstration
- Conduct field demonstration
- Prepare user data package with final design drawings

ANNUAL PERFORMANCE REVIEW: The project was terminated mid-year. Paint disposal costs had been \$2.60/lb in the San Diego area at project start. An updated survey showed that cost had dropped to \$0.45/lb for activities in San Diego area and \$0.50/lb at PWC Jacksonville. The solar paint dehydration technique, which will cost about \$0.75/lb is no longer cost effective. The design and performance data will be saved so that the technology could be applied in the future if paint disposal costs should rise above the \$1.00/lb level.

PROJECT SUMMARY

TITLE: Visual Cleaning Performance Indicators for Cleaning Verification

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603716D

IS THIS A CONGRESSIONAL INTEREST ITEM? No.

DESCRIPTION: The visual cleaning performance indicators (VCPI) are a combination of intense dyes and coupling agents (CA) that selectively attach to target contaminants on surfaces cleaned in Department of Defense (DoD) and Department of Energy (DOE) operations. This innovative technology promises to provide a widely-applicable, real-time, low-cost, quantitative/qualitative cleaning process monitoring technique. The implementation of such a technique will reduce hazardous and non-hazardous waste and processing cost by avoiding excessive as well as inadequate cleaning and by enhancing implementation of environmentally friendly cleaning alternatives.

The project consists of three tasks that will be carried out by Battelle in collaboration with Air Force Research Laboratory and Naval Surface Warfare Center-Cardero. In Task 1, the DoD partners will help identify target contaminants for large surface cleaning. Battelle will then select commercially-available CAs and dyes, that can attach to the target contaminants, using known science and with input from DoD partners on material compatibility. The Task 2 consists of feasibility testing of the VCPI concept. The DoD partners will prepare coupons for testing and Battelle will source the contaminant CAs and dyes. In the Task 3, Battelle will clean the VCPI-treated soiled coupons to demonstrate a relationship between color intensity and residual contaminant level. The DoD partners on the other hand will perform application-specific cleaning to determine whether VCPI components are compatible with DoD cleaning operations and materials of construction.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Identify contaminant types
- Select coupling agents
- Select compatible dyes
- Prepare samples for testing (intermittent)
- Demonstrate bonding (labeling) capability
- Complete Annual Technical Report

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Materials and Process Partnership for Pollution Prevention

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: The objective of this project is to: develop, demonstrate & validate pollution prevention cost saving technologies for DoD acquisition, sustainment and industrial base. This project will develop and transition Pollution Prevention technologies that affect the manufacture, operation, sustainment and decommission of weapon systems. It will accomplish this by soliciting proposals that address high priority DoD environmental quality requirements.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Conduct call for proposals to solicit issues
- Develop alternative P2 solutions to address issues
- Transition solutions to industry

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

PROJECT SUMMARY

TITLE: Radford Environmental Development and Management Program (REDMAP)

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602720A

IS THIS A CONGRESSIONAL INTEREST ITEM? Yes.

DESCRIPTION: The objective of this project is to: install an automated, real-time environmental quality monitoring and control system at Radford Army Ammunition Plant (RFAAP) to preclude chemical leaks and reduce waste by 50%; identify High Priority P2 & environmental quality monitoring/control needs based on cost and avoidance; implement pollution prevention technologies; and implement International Organization of Standards (ISO) 14000, Environmental Management System (EMS). The approach will involve the following tasks:

- Analyze and prioritize needs/requirements.
- Propose conceptual design modules/system.
- Implement modules/system.

ANNUAL PERFORMANCE OBJECTIVES FOR FY99:

- Perform baseline site review of RFAAP for Facility Environmental Management and Monitoring System (FEMMS) modules and P2/treatment projects
- Identify environmental management, monitoring and control capabilities
- Design and implement FEMMS modules
- Identify, evaluate and implement P2/treatment projects for RFAAP
- Implement ISO 14000 EMS.

ANNUAL PERFORMANCE REVIEW: Met all performance objectives.

LIST OF ACRONYMS

3-D	Three-Dimensional
AAR	Annular After Reactor
AB	After-burner
ABL	Airborne Laser
AC&R	Air-Conditioning and Refrigeration
ACA	Air Compliance Advisor
ACM	Asbestos-Containing Material
ADN	Ammonium Dinitramide
AEMSS	Advanced Enclosed Mast Sensor System
AERTA	Army Environmental Requirements and Technology Assessments
AF	Antifouling
AF	Air Force
AFB	Air Force Base
AFFF	Aqueous Film Forming Foam
AFIT	
AFRL	Air Force Research Laboratory
AFRL/ML	Air Force Research Laboratory Materials and Manufacturing Directorate
AIM	Acoustic Integration Model
ALC	Air Logistics Center
ALPC	Advanced Low Pollution Coating
ALT	Acquisition, Logistics and Technology
AN	Ammonium Nitrate
ANN	Artificial Neural Network
AOP	Advanced Oxidation Process
APM	Air Pollution Modeling
ARAMS	Army Risk Assessment Modeling System
ARDEC	Armament Research, Development and Engineering Center
ARL	Army Research Laboratory
ARO	Army Research Office
ARO	Advanced Reverse Osmosis
ASA	Assistant Secretary of the Army
ASTM	American Society for Testing and Materials
ASTMP	Army Science and Technology Master Plan
ASTWG	Army Science and Technology Working Group
ATD	Advanced Technology Demonstration
ATOFMS	Aerosol Time-Of-Flight Mass Spectrometer
ATTACC	Army Training and Testing Area Carrying Capacity
BAA	Broad Agency Announcement
BAM	Baseline Assessment Memorandum
BFS	Benthic Flux Sampling Device
BMDO	Ballistic Missile Defense Organization
BOD	Biochemical Oxygen Demand
BRAC	Base Realignment and Closure
CA	Coupling Agents

CAH	Chlorinated Aliphatic Hydrocarbons
CAMS	Central Atmosphere Monitoring System
CAPERS	Computer Assisted Planning and Emergency Response System
CARC	Chemical Agent Resistant Coating
CAV	Composite Armored Vehicle
CBC	Construction Battalion Center
CBF	Confined Burn Facility
CBM	Condition-Based Maintenance
CCAD	Corpus Christi Army Depot
CDF	Confined Disposal Facilities
CEM	Continuous Emissions Monitor
CEP	Metal Catalytic Extraction Process
CENR	Committee on Environment and Natural Resources
CFC	Chlorofluorocarbon
CFD	Computational Fluid Dynamics
CIWS	Close-In Weapons System
CLANWS	China Lake Naval Air Weapons Station
CLAWWRS	Closed Loop Aircraft Washrack Wastewater Recycle System
CMP	Copper Measurement Program
CMRS	Chemical Munitions Remediation System
CMS	Cylindrical Magnetron Sputtering
CNO	Chief of Naval Operations
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
COTS	Commercial Off-The-Shelf
CPT	Cone Penetrometer Technology
Cr ⁺³	Trivalent Chromium
Cr ⁺⁶	Hexavalent Chromium
CSF	Catalyzed Soot Filters
CVD	Chemical Vapor Deposition
CW	Camp Williams
CWA	Clean Water Act
CWM	Chemical Weapon Munition
DARPA	Defense Advanced Research Projects Agency
DASA	Deputy Assistant Secretary of Army
DASN	Deputy Assistant Secretary of Navy
DCBF	Demonstration-Scale Confined Burn Facility
DDR&E	Defense Research & Engineering
Dem/Val	Demonstration/Validation
DETRS	Defense Environmental Security Technology Requirements Strategy
DHR	Directional Hemispherical Reflectance
DLA	Defense Logistics Agency
DL-LIBS	Downhole-Laser LIBS
DNA	Deoxyribonucleic Acid
DNAPL	Dense Non-Aqueous Phase Liquid
DoD	Department of Defense
DOE	Department of Energy
DOM	Diocetyl Maleate
DOT	Department of Transportation
DPG	Defense Planning Guidance

DSU	
DT	Developmental Test
DTAP	Defense Technology Area Plan
DTO	Defense Technology Objectives
DUSD	Deputy Under Secretary of Defense
E&S	Environment and Safety
EA	Environmental Assessment
EAM	Effective Area Model
ECP	Engineering Change Proposal
ECRS	Experimental Controlled Release System
EDM	Engineering Development Model
EDYS	Ecological Dynamics Simulation
EER	Energy and Environmental Research
EIS	Environmental Impact Statement
EM	Electromagnetic
EMI	Electromagnetic Induction
EMS	Environmental Management System
EPA	Environmental Protection Agency
EQ	Environmental Quality
EQT	Environmental Quality Technology
ERDS	Emergency Response Data Sheet
ERPM	Emission Reduction Planning Model
ERU	Electrolytic Recovery Unit
ES	Environmental Security
ESA	Endangered Species Act
ESOH	Environmental Safety and Occupational Health
ESTCP	Environmental Security Technology Certification Program
ESTRG	Environmental Security Technology Requirements Group
ETIPT	Environmental Quality Technology Integrated Process Team
ETTC	Environmental Technology Technical Council
ETV	Environmental Technology Verification
FAS	Fuel Automated System
FB	Fort Bliss
FDEM	Frequency Domain Electromagnetic
Fe	Iron
Fe ²⁺	Ferrous Iron
FEMMS	Facility Environmental Management and Monitoring System
FFTF	Fire Fighter Training Facilities
FISC	Fleet And Industrial Supply Center
FJSIM	Fuel Jettisoning Simulation Model
FLSR	Flammable Liquid Storeroom
FO-LIBS	Fiber-Optic Laser Induced Breakdown Spectroscopy
FPD	Freezing Point Depressant
FTIR	Fourier Transform Infrared
GC/MS	Gas Chromatography/Mass Spectrometry
GE	General Electric
GIS	Global Information System
GMS	Groundwater Modeling System

gph	Gallons Per Hour
GPR	Ground-Penetrating Radar
GPS	Global Positioning System
GRFL	Groundwater Remediation Field Laboratory
H ₂	Hydrogen
HAFB	Hill Air Force Base
HAP	Hazardous Air Pollutant
HBCU	Historical Black Colleges and Universities
HEPA	High Efficiency Particulate Air
hex-Cr	Hexavalent Chromium
HFB	Hierarchical Foreground Background
HMX	Cyclotetramethylenetetranitramine
HVOF	High Velocity Oxygen Fuel
HW	Hazardous Waste
I&E	Installations and Environment
IDR	Initiation Decision Report
IFRSC	
IHPTET	Integrated High Performance Turbine Engine Technology
IL&E	Integrated Logistics & Environment
ILDS	Integrated Liquid Discharge System
IMS	Ion Mobility Spectroscopy
IPM	Integrated Pest Management
IPR	In Progress Review
IPT	Integrated Process Team
IR	Infrared
IR	Investment Recovery
IRZ	In-Situ Reactive Zone
ISO	Internal Organization of Standards
ISRM	In Situ Redox Manipulation
ITMS	Ion Trap Mass Spectrometer
IUSS	Integrated Undersea Surveillance System
IVD	Ion Vapor Deposition
IWTP	Industrial Wastewater Treatment Plants
JEMP	Joint Engineers Management Panel
JETC	Jet Engine Test Cell
JTP	Joint Test Protocol
L&M	Land and Marine
LANDSAT	Land Remote-Sensing Satellite
LANL	Los Alamos National Laboratory
LATRA	Launch Area Toxic Risk Assessment
LBP	Lead-Based Paint
LCO ₂	Liquid CO ₂
LFA	Low Frequency Active
LIBS	Laser Induced Breakdown Spectroscopy
LMR	Living Marine Resources
LMRIS	Living Marine Resources Information System
LMS	Land Management System

LRDP	Low Range Differential Pressure
LSA	Low Solar Absorbance
MAJCOM	Major Command
MARPOL	Maritime Organizations Marine Pollution Convention
MBT	Membrane Biotreatment
MCB	Marine Corps Base
MEK	Methyl Ethyl Ketone
MEUF	Micellar-Enhanced Ultrafiltration
MF	Microfiltration
MF-EMI	Medium Frequency - Electromagnetic Induction
MIBK	Methyl Isobutyl Ketone
MIC	Metastable Interstitial Composites
MIP	Membrane Interface Probe
MMPA	Marine Mammal Protection Act
Mn	Manganese
MPCD	Marine Pollution Control Device
MRC	Military Relevant Compounds
MRT	Molecular Recognition Technology
MSO	Molten Salt Oxidation
MTADS	Multi-Sensor Towed Array Detection System
MUC	Military Unique Compounds
NAAQS	National Ambient Air Quality Standards
NAPL	Non-Aqueous Phase Liquid
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NASF	Naval Air Station Fallon
NAWCWD	Naval Air Warfare Center Weapons Division
NCIBRD	National Center For Integrated Bioremediation Research and Development
NCSU	North Carolina State University
Nd-YAG	Neodinium-YAG
NDCEE	Nation Defense Center for Environmental Excellence
NDE	Nondestructive Evaluation
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NETTS	National Environmental Technology Test Sites
NFESC	Naval Facilities Engineering Service Center
NFMS	National Marine Fisheries Service
NGP	Next Generation Fire Suppression Technology Program
NMML	National Marine Mammal Laboratory
NOx	Nitrogen Oxides
NRL	Naval Research Laboratory
NSTC	National Science and Technology Council
NTL	National Test Location
NTP	Non-Thermal Plasma
OB/OD	Open Burn/Open Detonation
OCM	Oil Content Monitor
ODC	Ozone Depleting Chemical
ODS	Ozone Depleting Substances

OEM	Original Equipment Manufacturers
OEWS	Ordnance Explosive Wastes
OSD	Office of the Secretary of Defense
OSHA	Occupational Safety and Health Administration
OSU/ESL	Ohio State University/Electroscience Laboratory
OWS	Oil/Water Separators
OWTS	Oily-Wastewater Treatment Systems
P2	Pollution Prevention
PAA	Phosphoric Acid Anodize
PAH	Polycyclic Aromatic Hydrocarbon
PAHWTS	Plasma Arc Hazardous Waste Treatment System
PAS	Photoelectric Aerosol Detector
PAWDS	Plasma Arc Waste Destruction System
Pb	Lead
PCB	Polychlorinated Biphenyl
PCBF	Pilot-Scale Confined Burn Facility
PCE	Perchloroethylene (Tetrachloroethylene)
PE-ECD	Photoemissive Electron Capture Detector
PE-IMS	Photoemissive Ion Mobility Spectrometer
PEL	Permissible Exposure Limits
PEO	Program Executive Officer
PEP	Propellant, Explosives, and Pyrotechnics
PEPS	Plasma Energy Pyrolysis System
PID	Photo Ionization Detector
PLIPS	Portable Laser Induced Plasma Spectroscopic System
PM	Particulate Matter
PMC	Polymer-Matrix Composite
PMP	Project Management Plan
POC	Point of Contact
POL	Petroleum, Oil, and Lubricants
POLCS	Prototype Oxygen Line Cleaning System
POM	Program Objectives Memorandum
POTW	Publicly Owned Treatment Works
ppb	Parts Per Billion
PPBES	Planning, Programming, Budgeting and Execution System
PPLN	Periodically-Poled Lithium Niobate
PRB	Permeable Reactive Barrier
PSNS	Puget Sound Naval Shipyard
PTFE	Polytetrafluoroethylene
PVA	Polyvinyl Alcohol
PVD	Physical-Vapor-Deposited
QA/QC	Quality Assurance/Quality Control
R&D	Research and Development
RAB	Remedial Advisory Board
RCRA	Resource Conservation and Recovery Act
RCW	Red-Cockaded Woodpecker
RDBMS	Relational Database Management System
RDT&E	Research, Development, Test, and Evaluation

RDX	Cyclotrimethyle netrinitramine
REDMAP	Radford Environmental Development and Management Program
REMPI	Resonance Enhanced Multi-Photon Ionization
RFAAP	Radford Army Ammunition Plant
Rn	Radon-222
RNA	Remediation by Natural Attenuation
RTDF	Remedial Technologies Development Forum
RTV	Room Temperature Vulcanizing
RUSLE	Revised Universal Soil Loss Equation
SAB	Scientific Advisory Board
SAF/MIQ	Deputy Assistant Secretary of the Air Force (Environment, Safety and Occupational Health)
SALSA	Semi-Arid Land Surface Atmosphere
SAR	Synthetic Aperture Radar
SCAPS	Site Characterization and Analysis Penetrometer System
SCF	Supercritical Fluid
SCWO	Supercritical Water Oxidation
SEMP	SERDP Ecosystems Management Program
SER	Surface-Enhanced Raman
SERDP	Strategic Environmental Research and Development Project
SHIMS	Submarine Hazardous Materials Inventory Management System
SiC	Silicon Carbide
SIP	State Implementation Plan
SKP	Scanning Kelvin Probe
SNCR	Selective Non-Catalytic Reduction
SODS	Seismic Ordnance Detection System
SRM	Standard Reference Material
S&T	Science and Technology
STO	Science and Technology Objectives
SUPSALV	Supervisor of Salvage and Diving
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
SYSCOM	Systems Command
TAC	Technical Advisory Committee
TAR	Technology Area Review
TARA	Technology Area Review and Assessment
TAT	Turn Around Time
TCE	Trichloroethylene
TDS	Thermal Desorption
TEMPALT	Temporary Alterations
TES	Threatened, Endangered, and Sensitive Species
TID	
TIR	Technology Investment Review
TIR	Thermal Infrared
TLM	Test Location Manager
TNT	Trinitrotoluene
TPE	Thermoplastic Elastomer
TPIPT	Technical Planning Integrated Product Team
TRI	Toxic Release Inventory

TSDS	Technology Safety Data Sheet
TSO	Test Systems Organisms
TSS	Total Suspended Solids
TTAWG	Technology Thrust Area Working Groups
TTS	Temporary Threshold Shift
UB	Ultra Broadband
UDP	User's Data Package
UF	Ultrafiltration
UFAL	Ultrafine Aluminum
UNDEERC	University of North Dakota Energy and Environment Research Center
UNDS	Uniform National Discharge Standards
USAF	United States Air Force
USDA	United States Department of Agriculture
UST	Underground Storage Tank
UVF	Ultraviolet Fluorescence
UWB	Ultra-Wideband
UXO	Unexploded Ordnance
VARTM	Vacuum Assisted Resin Transfer Molding
VCC	Vortex Containment Chamber
VCPI	Visual Cleaning Performance Indicators
VNIR	Visible/Near Infrared
VOC	Volatile Organic Compound
WASI	Wide-Area Spectral Imaging
WB	Water-Based
WCFS	Water Compensating Fuel System
WETO	Western Environmental Technology Office
XRF	X-Ray Fluorescence

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